UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

DEPUY ORTHOPAEDICS, INC.
Petitioner

v.

ORTHOPAEDIC HOSPITAL
Patent Owner

Patent No. 8,658,710

Filing Date: May 24, 2007

Issue Date: February 25, 2014

Title: OXIDATION-RESISTANT AND WEAR-RESISTANT POLYETHYLENES FOR HUMAN JOINT REPLACEMENTS AND METHODS FOR MAKING THEM

Inter Partes Review No.: Unassigned

PETITION FOR *INTER PARTES* REVIEW OF U.S. PATENT NO. 8,658,710 UNDER 35 U.S.C. §§ 311-319 AND 37 C.F.R. §§ 42.100, *et seq*.

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I. INTRODUCTION

DePuy Orthopaedics, Inc. ("Petitioner" or "DePuy") petitions for *Inter Partes* Review ("IPR") under 35 U.S.C. §§ 311-319 and 37 C.F.R. §§ 42.1, *et seq*. and seeks the cancellation of claims 1 through 16 (the "challenged claims") of U.S. Patent No. 8,658,710 to McKellop, *et al*. ("the '710 patent") (Ex. 1001), which has been assigned to Orthopaedic Hospital ("Patent Owner" or "OH").

The '710 Patent attempts to claim previously known and disclosed methods for producing wear-resistant and oxidation-resistant medical implants. The challenged claims should never have been issued. After nearly a decade of examination, and numerous rejections, they were improvidently issued by a newly-assigned examiner after being amended to overcome a particular prior art combination. But that amendment fails to overcome other references and combinations that were not before the United States Patent and Trademark Office ("USPTO"). Nor does it overcome other references that had been cited previously against then-pending claims. For all the reasons set forth herein, DePuy asserts that there is a reasonable likelihood that it will prevail with respect to at least one of the challenged claims. DePuy respectfully requests that this Petition be granted.

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

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

DePuy Orthopaedics, Inc. is an affiliate of Johnson & Johnson and is the Real Party-In-Interest.

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

The '710 patent has been asserted against Petitioner in a litigation pending before the United States District Court for the Northern District of Indiana, styled as *Orthopaedic Hospital v. DePuy Orthopaedics, Inc.*, Civil Action No. 3:14-cv-00608-CAN, which has been consolidated into Civil Action No. 3:12-cv-00299-CAN. The litigation also includes claims for declaratory judgment and breach of contract related to a Patent Rights and License Agreement (the "license agreement") between Petitioner and OH. Under that agreement, DePuy had a license to the patent application that led to the '710 patent. Pursuant to the agreement, DePuy paid the fees to prosecute the '710 patent for a number of years. In 2012, prior to the allowance of the claims of the '710 patent, DePuy ceased funding the prosecution and advised OH that it did not believe that meaningful, valid claims could issue from the application. The parties contest whether the license agreement remains in force and, if so, whether the '710 patent is subject to the agreement. Contemporaneously with the filing of the present petition, DePuy is also filing a petition seeking *Inter Partes* Review of U.S. Patent No. 8,796,347 ("the '347 patent"), a related patent. Petitioner is not aware of any other related judicial or administrative proceeding or matter.

C. 37 C.F.R. § 42.8(b)(3): Lead And Back-Up Counsel
37 C.F.R. § 42.8(b)(4): Service Information

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III. MANDATORY FILINGS UNDER 37 C.F.R. §§ 42.10(b) and 42.63(e)

Concurrently filed herewith is the required power of attorney designating counsel and an Exhibit list.

IV. PAYMENT OF FEES UNDER 37 C.F.R. § 42.103

The Petitioner authorizes the USPTO to charge Deposit Account No. 501432 (Customer ID No. 362327-600011) for the fee required by 37 C.F.R. § 42.15(a) for this Petition, and further authorizes payment for any additional fees to be charged to this Deposit Account.

V. GROUNDS FOR STANDING UNDER 37 C.F.R. § 42.104(a)

Petitioner certifies that the '710 patent is eligible for IPR, and that Petitioner is not barred or estopped from requesting an IPR on the grounds identified herein. The present petition is being filed within one year of the March 18, 2014 service

date of the original complaint filed in United States District Court alleging that the Petitioner is infringing the '710 patent, as referenced in Section II.B, above. In that litigation, OH contends that DePuy is contractually and equitably estopped from asserting invalidity of the '710 patent. DePuy disagrees.

VI. BACKGROUND

A. The '710 Patent

The claims of the '710 patent are generally directed to a method of making wear-resistant, oxidation-resistant joint implants. The claimed method requires providing a polyethylene implant containing an antioxidant, and irradiating that implant at a dosage above 5 Mrad without employing a thermal treatment step during or after irradiation. Claim 1 is the only independent claim of the '710 patent.

The specification of the '710 patent primarily discloses and discusses the prior art. While all of the claims are directed to a polyethylene implant containing an antioxidant, only a single 13-line paragraph in the specification discloses such an embodiment. Ex. 1001 at 8:25-38 ("Method B: Aspect 1"). The only mention of such an embodiment ever having been made, however, is by reference to examples ***in two prior art references***. *Id*. at 8:39-43 ("An example of the application of this aspect is found in Mori et al and Tomita et al who used Vitamin E to improve the oxidation resistance of their UHMWPE."). Other than by

reference to the prior art, the specification discloses no specific formulation for an antioxidant-containing polyethylene. The '710 specification also lacks any data concerning a polyethylene implant containing an antioxidant.

B. Prosecution History And Priority Date Of The '710 Patent Claims

The '710 patent issued on February 25, 2014 from U.S. Application 11/805,867 ("the '867 application"), filed on May 24, 2007. The '867 application is a continuation of U.S. Application No. 10/258,762 ("the '762 application"), filed on October 25, 2002, which is a national phase filing of PCT Application No. PCT/US01/13839 (the "PCT application"), filed on April 27, 2001.[1]

The '762 application is based on Provisional Application No. 60/200,525, filed April 27, 2000. That provisional application, however, makes no mention of a polyethylene implant having an antioxidant added to it. The 13-line discussion of "Method B: Aspect 1" — the only disclosure relating to adding an antioxidant to the polyethylene — was first introduced in the PCT application. The examiner thus refused to accord the priority date of the provisional application to claims of the '762 application reciting a polyethylene implant doped with an antioxidant.

After its filing as a continuation of the '762 application, the '867 application

[1] The '762 application issued as U.S. Patent No. 8,796,347 ("the '347 patent") with claims that are essentially identical to the claims of the '710 patent. As noted above, Petitioner is filing a petition seeking *Inter Partes* Review of the allowed claims of the '347 patent contemporaneously herewith.

was in prosecution for nearly seven years before claims were allowed in late 2013. Claims in the '867 application were repeatedly rejected by Examiner Susan Berman over the course of six years. The issued claims were allowed shortly after a new examiner replaced Examiner Berman, and after OH amended the claims to require no thermal treatment during or after irradiation. By amending the claims in this manner, OH effectively conceded that its previously claimed method — irradiating an antioxidant doped polyethylene implant at a dosage above 5 Mrad without post-irradiation annealing or remelting — was unpatentable.

Moreover, as with the '762 application, the claims of the '867 application were not accorded the priority date of the provisional application. Instead, the examiner determined that the '867 application claims "have an effective filing date of 10-25-2002 or possibly the 4-27-2001 filing date of PCT/US01/13839." Ex. 1002 at 417.[2] OH did not challenge that determination. Rather, OH advocated for a priority date of April 27, 2001 because the application that became the '710 patent "is a copy of the PCT application." Ex. 1002 at 358. Therefore, the earliest possible priority date for the claims of the '710 patent is April 27, 2001.

The '867 application received eight separate office actions rejecting the

[2] The citation to pages of Exhibits 1002, 1006 and 1007 are to the unique page numbers stamped in the lower right corner of these exhibits. For example, the citation "Ex. 1006 at 9:44-49" reflects page number "P.0009" (in the lower right corner of the page), lines 44 to 49 of the exhibit.

claims as anticipated by and/or obvious over various prior art references. For example, in an office action dated July 17, 2012, Examiner Berman rejected the claims over three combinations of prior art, including a rejection based on Lidgren and one based on Tomita in view of Merrill. Examiner Berman determined that Lidgren anticipated or rendered obvious the claims because Lidgren's Example 2 discloses irradiating a polyethylene material doped with Vitamin E from 0 to 20 Mrad without post-irradiation annealing or remelting. Ex. 1002 at 416-17. Examiner Berman also concluded that the only difference between Tomita's method and the pending claims was that Tomita teaches a preferred irradiation dose of 0.5 to 5 Mrads, while the claims of the '867 application recited a radiation dose of above 5 Mrad. *Id.* at 421. Examiner Berman found that it would have been obvious to employ higher radiation doses in view of Merrill, which obtains oxidation resistant, wear resistant polyethylene implants by applying irradiation doses of from 0.5 to 1,000 Mrad. *Id*. at 421-22.

In response, OH submitted an amendment with a declaration from Dr. Harry McKellop, one of the named inventors of the '867 application. OH argued that each of the prior art combinations cited by the examiner requires post-irradiation annealing or remelting, in contravention of the then pending claims of the '867 application. As to Lidgren, OH argued that a POSA would have understood it requires an annealing or melting step when irradiating polyethylene at a high dose,

even if vitamin E is present. *See id.* at 361-67. OH further argued that a POSA would have understood the combination of Tomita and Merrill to also require post-irradiation annealing or remelting, asserting that Tomita does not suggest omitting a post-irradiation remelting or annealing step when using elevated radiation doses, and that Merrill requires such a step. *Id.* at 375-76. In addition, OH submitted alleged evidence of secondary considerations of non-obviousness including commercial success, long-felt need, and data it argued showed unexpected results of the invention over Tomita. *Id.* at 368-72; 376-78.

At this point, a new examiner took over examination of the '867 application. The new examiner did not maintain the longstanding rejections based on Lidgren and the combination of Tomita and Merrill. *Id.* at 234. In an office action dated August 9, 2013, the new examiner indicated that OH's declaration and arguments were sufficient to overcome the pending rejections. *Id.* The examiner acknowledged OH's arguments regarding commercial success and long-felt need, but did not find them persuasive. *Id.* The new examiner, however, rejected the claims as unpatentable over the combination of two different references — Poggie and Schaffner. *Id.* at 235-37. The examiner determined that this combination teaches irradiating polyethylene doped with an antioxidant at a high dose, without post-irradiation remelting or annealing. *Id.*

In response, OH submitted another amendment and declaration. *Id.* at 118-

228. OH amended the claims to include that the method must be performed "without thermally treating the implant to extinguish free radicals in the irradiated and crosslinked implant during or subsequent to" irradiation. *Id.* at 121-22. By doing so, OH implicitly agreed that earlier versions of the claims that recited "without annealing or melting the irradiated and crosslinked implant " were not patentable. OH argued that Poggie did not meet the limitations of the newly amended claims because Poggie teaches that the polyethylene implant should be thermally treated to extinguish free radicals. *Id.* at 130-31. OH also contended that a POSA reading Poggie and Schaffner would not have believed that the thermal treatment step could be eliminated. *Id.* at 131.

The new examiner issued a notice of allowability on December 26, 2013, based on OH's amendment adding the negative limitation of "without thermally treating the implant to extinguish free radicals." The examiner found that this amendment overcame the obviousness rejection over the Poggie and Schaffner combination based on the belief that this combination discloses thermally treating the implant during irradiation.

While the examiner ultimately allowed the claims of the '710 patent to issue, the examiner did so without the benefit of critical references and arguments. For example, none of the pending rejections involved the Li reference, which was not of record during prosecution. Li teaches irradiating polyethylene at high doses to

obtain a wear-resistant and oxidation resistant implants, and (unlike the Merrill reference previously considered in combination with Tomita) expressly discloses that "no heating after irradiation is required." In addition, during the prosecution of the '867 application, the examiners did not utilize the claims in Lidgren to reject OH's claims. The Lidgren claims provide an independent basis for the unpatentability of the claims of the '867 application, and directly refute OH's incorrect assertion that Lidgren's method requires an annealing or remelting step. Had the examiner considered these additional arguments, the claims of the '710 patent would never have issued.

VII. IDENTIFICATION OF CHALLENGE UNDER 37 C.F.R. § 42.104(b)

A. 37 C.F.R. § 42.104(b)(1): Identification Of Relief Requested

Petitioner requests the institution of an IPR for claims 1-16 of the '710 patent, and the cancellation of claims 1-16.

B. 37 C.F.R. § 42.104(b)(2): Identification Of Prior Art And Specific Grounds For Challenge Of Claims

1. Prior Art References

An IPR is requested in view of the following prior art references:

- Japanese Laid-Open Patent Appl. No. JPA11-239611 to Tomita, *et al*. ("Tomita") (Ex. 1003, certified English Language translation provided as Ex. 1004). Tomita was laid open on September 7, 1999, and is prior art under 35 U.S.C. § 102(b) because it was published more than one year before April 27,

2001, the earliest possible priority date of the '710 patent.

- U.S. Patent No. 6,794,423 to Li ("Li") (Ex. 1005) was filed on July 26, 2000, and issued September 21, 2004. Li qualifies as prior art under 35 U.S.C. § 102(e)(2) because it was granted from an application filed on or before the earliest possible priority date of the '710 patent.
- International Pub. No. WO 98/01085 to Shen, *et al*. ("Shen") (Ex. 1006). Shen was published on January 15, 1998, and is prior art under 35 U.S.C. § 102(b) because it was published more than one year before the earliest possible priority date of the '710 patent.
- International Pub. No. WO 00/49079 to Lidgren, *et al*. ("Lidgren") (Ex. 1007). Lidgren was published on August 24, 2000, before the earliest possible priority date for the '710 patent, and is prior art under 35 U.S.C. § 102(a).

2. Specific Grounds For Challenge Of Claims

The following table identifies the specific statutory grounds and the prior art references establishing the challenged claims of the '710 patent are unpatentable.

Ground	35 U.S.C.	Challenged '710 Patent Claims	Basis for Unpatentability of Challenged Claims
1	§ 103	1-16	Tomita in view of Li and Shen
2	§ 103	1-16	Lidgren in view of Li and Shen

C. 37 C.F.R. §§ 42.104(b)(3)-(4): Claim Construction And How Construed Claims Are Unpatentable

Pursuant to 37 C.F.R. § 42.100(b), and solely for the purposes of this

review, Petitioner construes the claim language such that the claims are given their broadest reasonable interpretation in light of the specification of the '710 patent.

Petitioner respectfully submits that, for the purposes of this review, the Board should interpret the claim term "oxidation-resistant" to mean "more resistant to oxidation." Petitioner submits that the Board should construe the remaining language for each claim in accordance with its plain and ordinary meaning under the required broadest reasonable interpretation. Because the standard for claim construction at the USPTO is different than that used during district court litigation (*see In re Amer. Acad. of Sci. Tech Ctr.*, 367 F.3d 1359, 1364, 1369 (Fed. Cir. 2004); MPEP § 2111), Petitioner expressly reserves the right to argue a different claim construction in litigation for any term of the '710 patent as appropriate.

An explanation of how claims 1-16 of the '710 patent are unpatentable, including identification of where each claimed limitation is found in the prior art, is set forth below in Section IX.

D. 37 C.F.R. § 42.104(b)(5): Identification Of Supporting Evidence

Per 37 C.F.R. § 42.6(c), copies of the references are filed herewith, and an Exhibit List supporting the grounds for this Petition is attached. Included in the Exhibit List is the declaration of Steven Spiegelberg, Ph.D. (Ex. 1009) under 37 C.F.R. § 1.68, which explains what the prior art would have conveyed to a person of ordinary skill in the art ("POSA").

VIII. STATE OF THE ART AND LEVEL OF SKILL IN THE ART AT THE TIME OF THE PRIORITY DATE OF THE '710 PATENT

A POSA is presumed to be aware of all pertinent art and is a person of ordinary creativity. As of April 27, 2001, a POSA with respect to polyethylene for use in artificial joint implants would have had knowledge of the scientific literature concerning the use of irradiation to crosslink polyethylene and the addition of antioxidant to polyethylene to stabilize free radicals. A POSA as of April 27, 2001 would typically have had: (1) a Bachelor's Degree in Chemical Engineering, Mechanical Engineering, Biomaterial Engineering, Material Science, or another related field of science, as well as 5 to 10 years of related experience in the field of artificial orthopaedic implants or (2) an advanced degree in Chemical Engineering, Mechanical Engineering, Biomaterial Engineering, Material Science, or another related field of science, as well as 2 to 5 years of related experience in the field of artificial orthopaedic implants. Ex. 1009 at ¶ 19.

The use of polyethylene in artificial joint implants was well known before April 27, 2001. *Id*. at ¶ 21. It was also well known that polyethylene implants must be sterilized prior to implantation in the human body. *Id.* It was common in the industry to sterilize polyethylene with gamma radiation, also known as "γ-radiation," or electron beam radiation, also known as "β-radiation." *Id.* A typical sterilization dose was between 2.5 and 4 Mrads. *Id.*

It was also known that polyethylene wear debris contributes to long-term

failure of artificial joints, eventually causing the prosthesis to become loose and require replacement. *Id.* at ¶ 22. Therefore, it was desirable to improve the wear resistance of polyethylene used in artificial joint implants. *Id.* Before April 27, 2001, it was well known that irradiating polyethylene causes the polyethylene to crosslink, which was known to improve its wear resistance. *Id.* at ¶ 23. It was well known that increasing the radiation dose would increase the amount of crosslinking. *Id*. In addition, a POSA would have known that irradiating polyethylene generates free radicals within the polyethylene. *Id.* at ¶ 24. Free radicals that remain after irradiation are undesirable because they may lead to oxidation. *Id*. Oxidation may cause the material to become brittle, leading to increased wear, and ultimately failure of the implant. *Id.*

By April 27, 2001, a POSA would have known of two predominant methods to reduce or eliminate the free radicals remaining after irradiation. *Id.* at ¶ 25. In one method, an antioxidant is incorporated with the polyethylene. *Id.* at ¶ 26. The free radicals generated by the radiation process are stabilized by the antioxidant, limiting the free radicals from reacting with oxygen, and thereby inhibiting the oxidation process. *Id.* A POSA at this time would also have understood that adding antioxidant reduces the amount of crosslinking caused by the irradiation process. *Id.* As a result, a POSA would have understood that the radiation dosage

would need to be increased to obtain the amount of crosslinking necessary for the desired wear resistance. *Id.*

In the second method to reduce free radicals, the polyethylene is thermally treated after irradiation. *Id.* at ¶ 27. Thermal treatments of polyethylene included annealing and remelting. *Id.* A POSA at the time would have understood that each of these methods has drawbacks. *Id.* at 28. A POSA would have understood that remelting negatively impacts desirable mechanical properties of the polyethylene, such as fatigue resistance and tensile strength. *Id.* Annealing does not have such a negative impact on the mechanical properties of polyethylene, but it is not as effective at preventing long-term oxidation. *Id.*

A POSA would have understood that the use of antioxidants and the use of thermal treatment to reduce or eliminate free radicals generated by irradiation were interchangeable, and did not need to be used in combination with each other. *Id.* at ¶ 29. A POSA would have also understood that by using an antioxidant to reduce or eliminate free radicals, thermal treatment of the polyethylene would not be necessary or required. *Id.* The antioxidant method reduces or eliminates free radicals while preserving the desired mechanical properties of the polyethylene for use in medical implants. *Id.* While an antioxidant could be used in combination with a thermal treatment, it was not required to be so used.

IX. THERE IS A REASONABLE LIKELIHOOD THAT AT LEAST ONE CLAIM OF THE '710 PATENT IS UNPATENTABLE

As detailed in the discussion and claim charts below, the prior art references identified below demonstrate that all of the limitations of claims 1-16 of the '710 patent were known in the prior art at the time of invention. The inventions claimed in the '710 patent are "[t]he combination of familiar elements according to known methods" that "do[] no more than yield predictable results." *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 416 (2007). The claims of the '710 patent are no more than "the predictable use of prior art elements according to their established functions." *Id.* at 417.

A. Ground 1: Claims 1-16 Are Obvious Over Tomita In View Of Li And Shen

Tomita discloses a method for making an oxidation and wear resistant artificial joint by mixing an antioxidant with polyethylene, and irradiating the implant to crosslink the polyethylene. Ex. 1004 at [0001, 0007, 0013, 0015, 0017, 0021]. Li and Shen teach methods for making oxidation and wear resistant polyethylene implants. Ex. 1005 at 3:7-14, 5:9-12; Ex. 1006 at 9:44-49; 12:39-44. Li and Shen disclose irradiating polyethylene at higher radiation doses in order to generate crosslinking for the corresponding increase in wear resistance. Ex. 1005 at 5:19-27; Ex. 1006 at 15:29-34.

Tomita was cited during prosecution of the '710 patent, and was used to

reject the claims in Office Actions dated September 2, 2011 and July 17, 2012. Ex. 1002 at 458-461, 421-422. Shen was also of record during prosecution, but was not used as the basis for any rejection. Li was not of record during prosecution. The examiners never considered Tomita in combination with Li and Shen as discussed herein.

A POSA would have had reason to combine the teachings of Tomita with Li and Shen. All three references teach methods and processes for improving the wear resistance of polyethylene implants using irradiation. Ex. 1009 at ¶¶ 41-44. A POSA would have looked to Li to confirm that radiation dosages above 5 Mrads could be used to improve the Tomita process and increase the wear resistance of the Ultra High Molecular Weight Polyethylene ("UHMWPE") artificial joints without negatively affecting other characteristics. *Id*. at ¶ 44. A POSA would have also looked to Li for additional information regarding the processing of UHMWPE into implants, including fabricating techniques, and to confirm that no thermal treatment after irradiation was required. *Id.* at ¶ 45.

A POSA looking to optimize the wear-resistance properties of Tomita's implants would have looked to Shen's disclosure of the preferred range of parameters that are indicative of reduced or non-detectable wear in artificial polyethylene joints made from irradiated UHMWPE. *Id.* at ¶ 46. A POSA would have understood that these ranges of swell ratio, molecular weight between

crosslinks and gel content are indicative of optimal wear performance of the implant, whether or not it contains an antioxidant. *Id.* In addition, a POSA would have looked to Shen's disclosures on processing and packaging techniques. *Id.*

A POSA would have understood that the teachings of Li and Shen are applicable to improving the process disclosed in Tomita, even though Li and Shen do not involve the addition of an antioxidant to the UHMWPE material. *Id.* at ¶ 47.

Claim 1:

'710 Patent Claims	**Tomita (Ex. 1004), Li (Ex. 1005) and Shen (Ex. 1006)[3]**
1. A method for producing a wear-resistant and oxidation-resistant medical implant of a joint prosthesis, said method comprising the steps of:	Tomita: A "sliding member for **artificial joints**, made of polyethylene, which is used for artificial joints for **medical use**" and a manufacturing method for such member (Ex. 1004, [0001]); "it excels in **oxidation resistance**" and "**wear resistance** and fatigue resistance, for which oxidation is thought to be a cause, are improved." Ex. 1004 at [0026].
(I) providing an oxidation-resistant medical implant of a joint prosthesis comprising a polyethylene component; and	Tomita: A "sliding member for **artificial joints** can be manufactured by molding the above described **polyethylene composition."** Ex. 1004 at [0015], [0017].
(II) irradiating the oxidation-resistant medical implant at a radiation dose of above 5 Mrad to about 25 Mrad so as to crosslink the	Tomita: "**There is no particular limitation on dose of irradiation** so long as sterilization can be done, but it is preferable that the irradiation dose be enough **to cause sufficient crosslinking reactions in the polyethylene**." Ex. 1004 at [0021]. Tomita: A radiation dose of "0.5 to **5 Mrad**" is preferred

[3] As used in this petition, boldface type in all claim charts is added emphasis.

'710 Patent Claims	Tomita (Ex. 1004), Li (Ex. 1005) and Shen (Ex. 1006)[3]
implant thereby improving its wear resistance, without thermally treating the implant to extinguish free radicals in the irradiated and crosslinked implant during or subsequent to irradiating the oxidation-resistant implant; wherein	to sterilize and crosslink the polyethylene; "[**c**]**rosslinking** of the **polyethylene improves the wear resistance** of the sliding member for artificial joints." Ex. 1004 at [0021]. Li: An invention "directed to a total joint replacement . . . comprising a shaped crosslinked article made from UHMWPE . . . with irradiation at a dose higher than **4 Mrads, preferably 5 Mrads, and most preferably less than 10 Mrads.**" Ex. 1005 at 3:15-20. Li: "At every dose from 2.5 **to 50 Mrads**, directly molded samples had higher toughness than the corresponding extruded [ ] sample. The increased toughness . . . is so significant that **it is possible to use a higher irradiation dose** . . . and still obtain a higher toughness value . . . ." Ex. 1005 at 4:40-46. Li: "**[N]o heating after irradiation is required**" and "**Heating** the irradiated material to the melting point of UHMWPE **is not desirable and can cause deleterious effects** . . . ." Ex. 1005 at 5:60-67.
[i] the oxidation-resistant implant contains an antioxidant rendering it resistant to oxidation caused by free radicals generated by the irradiation of step (II); and	Tomita: "**[I]rradiation with gamma rays produces free radicals** within polyethylene, and oxidation occurs as they react with oxygen . . . ." Ex. 1004 at [0004]. Tomita: "[T]o solve the drawbacks of polyethylene sliding members . . . and to improve their wear resistance; as a result, they discovered that fatigue resistance can be dramatically improved by **using vitamin E group, as an oxidation inhibitor** . . . ." Ex. 1004 at [0007]. Tomita: "The sliding member for artificial joints . . . is molded with a polyethylene composition containing the above described polyethylene and **vitamin E group**." Ex. 1004 at [0013].
[ii] the irradiated oxidation-resistant implant possesses the characteristics of: a degree of swelling of between about 1.7 to about 3.6; a molecular	Shen: "The present invention discloses methods for enhancing the wear-resistance of polymers, the resulting polymers, and the ***in vivo*** **implants** made from such polymers." Ex. 1006 at Abstract. Shen: "[A]cetabular cups [implants] made from UHMWPE falling within a preferred range of these physical parameters have reduced or non-detectable wear.

<table>
<tr><th>‘710 Patent Claims</th><th>Tomita (Ex. 1004), Li (Ex. 1005) and Shen (Ex. 1006)[3]</th></tr>
<tr><td>weight between crosslinks of between about 400 to about 3,500 g/mol; and a gel content of between about 95% to about 99%.</td><td>The ranges of these physical parameters include one or more of the following: a degree of swelling of between about 1.7 to about 5.3; molecular weight between crosslinks of between about 400 to about 8400 g/mol; and a gel content of between about 95% to about 99%.” Ex. 1006 at 17:41-47.
Shen: “The degree of swelling, average molecular weight between crosslinks, crosslink density and gel content are shown in Table 7.” Ex. 1006 at 50:27-29.
Table 7
<table><tr><th rowspan="2">Samples</th><th colspan="4">Non- remelted</th></tr><tr><th>Degree of swelling</th><th>M.W. between crosslinks (g/mol)</th><th>Crosslink density (mol%)</th><th>Gel content (%)</th></tr><tr><td>3.3 Mrad</td><td>5.29</td><td>8400</td><td>0.17</td><td>94.7</td></tr><tr><td>4.5 Mrad</td><td>3.57</td><td>3500</td><td>0.40</td><td>97.8</td></tr><tr><td>9.5 Mrad</td><td>2.82</td><td>1900</td><td>0.74</td><td>98.6</td></tr><tr><td>14.5 Mrad</td><td>2.35</td><td>1100</td><td>1.27</td><td>98.7</td></tr><tr><td>20.2 Mrad</td><td>2.27</td><td>1000</td><td>1.40</td><td>98.8</td></tr><tr><td>24 Mrad</td><td>2.17</td><td>900</td><td>1.56</td><td>98.7</td></tr><tr><td>50 Mrad</td><td>1.92</td><td>600</td><td>2.33</td><td>98.7</td></tr><tr><td>100 Mrad</td><td>1.71</td><td>400</td><td>3.50</td><td>98.6</td></tr></table></td></tr>
</table>

The combination of Tomita, Li and Shen meets every limitation of claim 1, thereby rendering it obvious. The preamble of claim 1 discloses a method for making wear resistant and oxidation resistant medical implants for a joint prosthesis. Tomita discloses a “manufacturing method” used to make “artificial joints for medical use” (Ex. 1004 at [0001]) that “excels in oxidation resistance” and for which “the wear resistance and fatigue resistance . . . are improved” (*id*. at [0026]).

Limitation (I) of claim 1 requires the joint prosthesis to be comprised of a

polyethylene component, and is met by Tomita's disclosure of "[a] sliding member for artificial joints can be manufactured by molding . . . [a] polyethylene composition." *Id*. at [0015, 0017].

The combination of Tomita and Li meets the irradiation limitation of claim 1. Limitation (II) of claim 1 requires irradiating the implant with a dose of "above 5 Mrad to about 25 Mrad" to crosslink the implant thereby improving its wear resistance. Tomita teaches that there is "**no particular limitation on dose of irradiation** . . . [and] that the irradiation **dose be enough to cause sufficient crosslinking** reactions in the polyethylene." Ex. 1004 at [0021] (emphasis added). Tomita discloses a preferred radiation dosage of 0.5-5 Mrad to crosslink the polyethylene, which "improves the wear resistance of . . . artificial joints." *Id*. However, a POSA would have understood that the addition of an antioxidant inhibits polyethylene crosslinking (*i.e.*, increasing the amount of antioxidant results in greater inhibition of crosslinking), thereby requiring an increased radiation dosage to effect sufficient crosslinking for improved wear resistance. Ex. 1009 at ¶ 51. A POSA thus would have understood Tomita's disclosure of "no particular limitation on dose of radiation" to suggest that radiation dosages above 5 Mrad may be required to achieve the desired amount of crosslinking in the presence of antioxidant. *Id*. In addition, Li teaches crosslinking polyethylene in artificial joints, with wear resistance improving for doses up to "about 100 Mrads" (Ex.

1005 at 4:8-10), and that at "dose[s] from 2.5 to 50 Mrads" the polyethylene still maintains other desirable characteristics (*id*. at 4:40-47). Thus, the combination of Tomita and Li discloses the claimed radiation dose of "above 5 Mrad to about 25 Mrad."

When the ranges in a claimed composition or process overlap the ranges disclosed in the prior art, a *prima facie* case of obviousness typically exists. *In re Peterson*, 315 F.3d 1325, 1329 (Fed. Cir. 2003). A prior art range that completely encompasses the claimed range establishes an even more compelling *prima facie* case of obviousness than in cases of overlap. *Id.* at 1330. This is because "[t]he normal desire of scientists or artisans to improve upon what is already generally known provides the motivation to determine where in a disclosed set of percentage ranges is the optimum combination of percentages." *Id*. (citation omitted). The combination of Tomita and Li discloses an irradiation dosage range that completely subsumes the range of claim 1 of the '710 patent. The claimed range is, thus, *prima facie* obvious over Tomita in view of Li. *See Peterson*, 315 F.3d at 1330 (finding a compelling *prima facie* case of obviousness when the claimed range is subsumed within a prior art range).[4]

The "without thermally treating the implant" during or subsequent to

[4] Further, Li's preferred range is between 5 and 10 Mrads. *See* Ex. 1005 at 3:15-20. This is an embodiment of the above 5 to about 25 Mrads range set forth in claim 1.

irradiation requirement of limitation (II) in claim 1 is a negative limitation — a limitation that defines the claimed subject matter by what it is not, rather than by what it is. *Upsher-Smith Labs, Inc. v. Pamlab, LLC*, 412 F.3d 1319, 1322 (Fed. Cir. 2005). The Board has held that a negative limitation may be satisfied by silence in the prior art. *Clio USA, Inc. v. Procter & Gamble Co.*, Case IPR2013-00448, Paper 15 at 3-4; *Ex parte Cheng*, No. 2007-0959, Opinion in Support of Decision at 5-6 (B.P.A.I. May 7, 2007) (holding that negative limitation "without sending the data from the host memory to an embedded memory…" was disclosed by silence); *see also Upsher-Smith Labs*, *Inc.*, 412 F.3d at 1322; *Sud-Chemie, Inc. v Multisorb Techs., Inc.*, 554 F.3d 1001, 1004-05 (Fed. Cir. 2009).

In this case, Tomita does not disclose or describe any thermal treatment during or after the irradiation step. In fact, Tomita teaches that "gamma ray irradiation followed by annealing . . . also is unreliable" because "oxidation during gamma ray irradiation cannot be suppressed." Ex. 1004 at [0005]. Thus, Tomita alone meets the no thermal treatment requirement.

Further, Li teaches a process in which "no heating after irradiation is required," and that such heating "can cause deleterious effects." Ex. 1005 at 5:60-67. A POSA looking to improve the wear characteristics or increase the amount of crosslinking in Tomita by increasing the radiation dose would have known from Li that it was unnecessary to add a thermal treatment step following the radiation. Ex.

1009 at ¶ 53. A POSA would have known that using an antioxidant and adding a thermal treatment step serve the same purpose — to reduce the number of free radicals available for oxidation. *Id.* Therefore, in light of the teachings of Tomita and Li, a POSA would have understood that there was no need for thermal treatment of the implant disclosed by Tomita during or after irradiation, even if a radiation dose above 5 Mrads was used. *Id.*

During prosecution, OH argued that "Tomita is silent on post-irradiation annealing or remelting," and that the secondary reference then being combined with Tomita (*i.e.*, Merrill) teaches "post-irradiation remelting or annealing." Ex. 1002 at 375. First, OH's argument regarding Tomita's "silence" with regard to thermal treatment is legally incorrect; silence is sufficient to disclose the negative limitation in the claim. *See Cheng*, No. 2007-0959 at 5-6. Second, to the extent that the examiner determined that a POSA would have believed that remelting or annealing were required at higher radiation doses (based on OH's argument about Merrill and Lidgren), Li directly refutes that conclusion. Li plainly teaches that thermal treatment is not required, even at radiation doses above 5 Mrads (Ex. 1005 at 5:65-67), and the examiner never considered Tomita in combination with Li.

Tomita meets limitation [i] of claim 1, which requires the implant to contain an antioxidant rendering it resistant to oxidation caused by free radicals generated by the irradiation step. Tomita teaches that "irradiation . . . produces free radicals

within polyethylene, and oxidation occurs . . . .” Ex. 1004 at [0004]. To address the oxidation caused by free radicals, Tomita discloses “using vitamin E group, as an oxidation inhibitor . . . .” *Id*. at [0007, 0013].

Limitation [ii] of claim 1, the physical parameters of the implant, are met by the disclosure in Shen. A POSA looking to optimize the wear resistance of the polyethylene implant of Tomita would have looked to Shen for its disclosure of ranges of physical characteristics that are indicative of reduced or non-detectable wear in artificial joints made of irradiated polyethylene. Ex. 1009 at ¶ 55. The physical parameters disclosed in Shen include: (1) a degree of swelling of between about 1.7 to about 5.3; (2) molecular weight between crosslinks of between about 400 to about 8400 g/mol; and (3) a gel content of between about 95% to about 99%. Ex. 1006 at 17:41-47. Shen further teaches that these ranges can be achieved without thermally treating polyethylene irradiated by doses within the 5-25 Mrad range claimed in claim 1 of the ‘710 patent. *See* Ex. 1005 at 58, Table 7:

Table 7

Samples	Non- remelted			
	Degree of swelling	M.W. between crosslinks (g/mol)	Crosslink density (mol%)	Gel content (%)
3.3 Mrad	5.29	8400	0.17	94.7
4.5 Mrad	3.57	3500	0.40	97.8
9.5 Mrad	2.82	1900	0.74	98.6
14.5 Mrad	2.35	1100	1.27	98.7
20.2 Mrad	2.27	1000	1.40	98.8
24 Mrad	2.17	900	1.56	98.7
50 Mrad	1.92	600	2.33	98.7
100 Mrad	1.71	400	3.50	98.6

A POSA would have understood that "Non-remelted," as used in Table 7, means polyethylene that has not been subject to thermal treatment following irradiation. Ex. 1009 at ¶ 56. A POSA would have readily understood that the ranges of physical characteristics in claim 1 could be obtained by adjusting the radiation dosage and the weight percentage of antioxidant. *Id.* at 57.

The physical parameter limitations of the '710 patent were added to claim 1 by amendment dated July 7, 2008. Ex. 1002 at 784-89. These ranges correspond to the reported values for non-remelted polyethylene that had been radiated at 4.5 Mrad and 100 Mrad in Shen's Table 7, shown in highlights above. The range of the radiation dose specified in this claim amendment was "above 5 Mrad to about 100 Mrad." *Id.* at 786. During prosecution, OH limited the claimed range of the radiation dose to "above 5 Mrad to about 25 Mrad," but the claimed physical property limitations remained the same. *See id.* at 351-352.

Claim 1 of the '710 patent attempts to claim ranges of polyethylene physical properties subsumed by those taught by Shen, and specifically disclosed in Shen. These limitations are *prima facie* obvious in view of Tomita, Li, and Shen. *See Peterson*, 315 F.3d at 1330.

For the foregoing reasons, claim 1 would have been obvious to a POSA over Tomita in view of Li and Shen.

Claims 2, 3, 6, 7 and 16:

'710 Patent Claims	Tomita (Ex. 1004), Li (Ex. 1005) and Shen (Ex. 1006)
2. The method of claim 1, wherein the radiation dose is from above 5 Mrad to about 10 Mrad.	*See* claim 1 in Section IX(A), above. Tomita: "**There is no particular limitation on dose of irradiation so long as sterilization can be done** . . . ."; a radiation dose of "0.5-**5 Mrad**" is preferred. Ex. 1004 at [0021]. Li: "[A] total joint replacement device or component . . . with irradiation at a dose higher than 4 Mrads, **preferably 5 Mrads, and most preferably less than 10 Mrads.**" Ex. 1005 at 3:15-20.
3. The method of claim 1, wherein the polyethylene is selected from the group consisting of: ultra high molecular weight polyethylene and high molecular weight polyethylene.	*See* claim 1 in Section IX(A), above. Tomita: use of "**ultra-high molecular weight polyethylene.**" Ex. 1004 at [0029].
6. The method of claim 1, wherein the irradiation is performed with radiation selected from the group consisting of: gamma radiation and electron beam radiation.	*See* claim 1 in Section IX(A), above. Tomita: "Sterilization is generally performed by irradiation such as with **gamma rays or an electron beam** etc." Ex. 1004 at [0004]. Tomita: "[M]anufacturing processing in order to solve the drawbacks of polyethylene sliding members . . . to improve their wear resistance . . . can be dramatically improved by using vitamin E group, as an oxidation inhibitor . . . and by irradiating the molded product with **gamma rays** . . . ." Ex. 1004 at [0007]. Tomita: "[R]adiation sterilization methods are broadly classified into a method that irradiates with electromagnetic radiation, such as **gamma rays**, or . . . such as **electron beams**; and either method may be used." Ex. 1004 at [0021].
7. The method of claim 1, wherein the irradiation also	*See* claim 1 in Section IX(A), above. Tomita: "**Sterilization** is generally performed by irradiation such as with gamma rays or an electron

'710 Patent Claims	**Tomita (Ex. 1004), Li (Ex. 1005) and Shen (Ex. 1006)**
sterilizes the implant.	beam etc." Ex. 1004 at [0004]. Tomita: "[S]liding member for **artificial joints** must be **sterilized** in order to be used for medical purposes . . . . [R]adiation **sterilization** methods are broadly classified into a method that irradiates with electromagnetic radiation, such as **gamma rays**, or . . . such as **electron beams** . . . ." Ex. 1004 at [0020-21].
16. The method of claim 1, wherein oxidation-resistant medical implant is irradiated at a radiation dose of above 10 Mrad to about 25 Mrad.	*See* claim 1 in Section IX(A), above. Li: "At every dose from 2.5 **to 50 Mrads**, directly molded samples had higher toughness than the corresponding extruded [ ] sample. The increased toughness . . . is so significant that **it is possible to use a higher irradiation dose** . . . and still obtain a higher toughness value . . . ." Ex. 1005 at 4:40-46. Li: "At least 6 samples (10x20x90mm) were irradiated at each of the following gamma irradiation doses: 2.5, 5, **10, 20, 50 Mrads**." Ex. 1005 at 7:1-3.

Claim 2 limits the method in claim 1 to a radiation dose above 5 Mrad to about 10 Mrad. As explained above, Tomita teaches that "[t]here is no particular limitation on dose of irradiation" (Ex. 1004 at [0021]), and a POSA would have understood that Tomita suggests radiation dosages above 5 Mrad because the antioxidant in polyethylene inhibits crosslinking. Ex. 1009 at ¶ 61. In addition, this claim would have been obvious to a POSA in view of Li's explicit teaching of a radiation dose of between 4 and 10 Mrad (Ex. 1005 at 3:15-20). Ex. 1009 at ¶ 61.

Claim 3 specifies that the polyethylene is selected from the group consisting of ultra high molecular weight polyethylene, or high molecular weight

polyethylene, and is met because Tomita teaches using ultra high molecular weight polyethylene. Ex. 1004 at [0029].

Claim 6 recites that the radiation is either gamma radiation or electron beam radiation. Claim 6 is met because Tomita teaches the use of either gamma or electron beam radiation. Ex. 1004 at [0004, 0007, 0021].

Claim 7 requires that the radiation sterilize the implant, and is met because Tomita teaches sterilizing the artificial joint. Ex. 1004 at [0004, 0020, 0021].

Claim 16 limits claim 1 to a radiation dose of above 10 Mrads to about 25 Mrads. As discussed in claim 2 above, Tomita discloses that the radiation dose is not limited (Ex. 1004 at [0021]) and Li teaches using doses from 2.5 to 50 Mrads (Ex. 1005 at 4:40-46). Thus, the combination of Tomita and Li would have disclosed each of the limitations of claim 16. *See Peterson*, 315 F.3d at 1330.

Claims 4 and 5:

'710 Patent Claims	**Tomita (Ex. 1004), Li (Ex. 1005) and Shen (Ex. 1006)**
4. The method of claim 1, wherein the anti-oxidant is selected from the group consisting of: vitamin A, vitamin C, vitamin E, phenols, aromatic amines, salts and condensation products of amines with aldehydes, ketones, or thio compounds, and salts and condensation products of aminophenols with aldehydes, ketones, or thio compounds.	*See* claim 1 in Section IX(A), above. Tomita: "[M]anufacturing processing in order to solve the drawbacks of polyethylene sliding members . . . to improve their wear resistance . . . can be dramatically improved by using **vitamin E group, as an oxidation inhibitor** . . ." Ex. 1004 at [0007]. Tomita: "The sliding member for artificial joints of the present invention is molded with a polyethylene composition containing the above described polyethylene and **vitamin E group**." Ex. 1004 at [0013].

'710 Patent Claims	Tomita (Ex. 1004), Li (Ex. 1005) and Shen (Ex. 1006)
5. The method of claim 4, wherein the anti-oxidant is vitamin E.	*See* claim 4, above in this chart.

Claim 4 provides the additional limitation that the antioxidant is selected from a group that includes Vitamin E. Claim 5 specifies that the antioxidant is Vitamin E. These claims are met because Tomita teaches using Vitamin E as the antioxidant. Ex. 1004 at [0007, 0013]. *See Atofina v. Great Lakes Chem. Co.*, 441 F.3d 991, 999 (Fed. Cir. 2006) ("an earlier species reference anticipates a later genus claim").

Claims 8 and 9:

'710 Patent Claims	Tomita (Ex. 1004), Li (Ex. 1005) and Shen (Ex. 1006)
8. The method of claim 1, wherein the oxidation-resistant medical implant is produced according to the process selected from the group consisting of: (a) mixing the anti-oxidant and polyethylene powder and fusing the mixture to produce an oxidation-resistant preformed polyethylene and machining the oxidation-resistant medical implant from the oxidation-resistant preformed polyethylene; and (b) mixing the anti-oxidant and the polyethylene powder and fusing the mixture in a mold to produce a direct molded	*See* claim 1 in Section IX(A), above. Tomita: "[S]liding member for artificial joints can be manufactured by . . . **mixing the above described polyethylene, vitamin E group**, and, as needed, the other components . . . ." Ex. 1004 at [0015]. Tomita: "[W]hen manufacturing the present invention's sliding member for artificial joints; **any well-known molding method can be used**, such as **extrusion molding, compression molding, injection molding** . . . the molded product that is formed by these molding methods **can be used as-is** as the present invention's sliding member for artificial joints, or after molding **it can be further machined** . . . ." Ex. 1004 at [0019]. Li: "**UHMWPE is commercially produced as a powder** . . . . The powder is **fabricated**

'710 Patent Claims	**Tomita (Ex. 1004), Li (Ex. 1005) and Shen (Ex. 1006)**
oxidation-resistant medical implant.	**into devices by** one of three methods: (1) **extrusion** into bars **followed by machining** of the device and (2) **compression molding** into sheets **followed by machining** and (3) **direct compression molding**." Ex. 1005 at 1:26-62.
9. The method of claim 8, wherein the polyethylene is selected from the group consisting of: ultra high molecular weight polyethylene and high molecular weight polyethylene.	*See* claim 8, above in this chart. Tomita: "Working Examples 1 to 3 After weighing 500 g of **ultra-high molecular weight polyethylene** . . . the prescribed amount of vitamin E . . . was measured and added." Ex. 1004 at [0029].

A POSA would have understood that claim 8 specifies two well known methods of manufacturing an oxidation-resistant polyethylene implant. Ex. 1009 at ¶ 70. The disclosure of Tomita meets each of the limitations of claim 8. Tomita teaches mixing polyethylene powder with Vitamin E powder (Ex. 1004 at [0015]), molding the mixture by extrusion, compression or injection molding with the molded product used "as-is" or "it can be further machined." (Ex. 1004 at [0019].) A POSA would have understood from Tomita that the implant could be made either by extrusion, compression molding and/or injection molding followed by a machining process, or by direct molding the implant to be used "as is." Ex. 1009 at ¶ 70. Additionally, Li teaches molding polyethylene powder by extrusion into bars that are machined (Ex. 1005 at 1:34-45), compression molded into sheets that

are machined (*id.* at 1:46-51), or direct compression molded into final shape without machining (*id.* at 1:52-56).

Claim 9 recites that the polyethylene must be either ultra high molecular weight polyethylene or high molecular weight polyethylene, and is met because Tomita teaches using ultra high molecular weight polyethylene. Ex. 1004 at [0029].

Claims 10 and 11:

'710 Patent Claims	**Tomita (Ex. 1004), Li (Ex. 1005) and Shen (Ex. 1006)**
10. The method of claim 1, wherein the polyethylene is selected from the group consisting of: ultra high molecular weight polyethylene and high molecular weight polyethylene; and the irradiation is performed with radiation selected from the group consisting of: gamma radiation and electron beam radiation.	*See* claim 1 in Section IX(A), above. Tomita: "Working Examples 1 to 3 After weighing 500 g of **ultra-high molecular weight polyethylene** . . . the prescribed amount of vitamin E . . . was measured and added." Ex. 1004 at [0029]. Tomita: "[R]adiation sterilization methods are broadly classified into a method that irradiates with electromagnetic radiation, such as **gamma rays**, or . . . such as **electron beams** . . . ." Ex. 1004 at [0021]; *see also* [0004], [0007].
11. The method of claim 10, wherein the anti-oxidant is selected from the group consisting of: vitamin A, vitamin C, vitamin E, phenols, aromatic amines, salts and condensation products of amines with aldehydes, ketones, or thio compounds, and salts and condensation products of aminophenols with aldehydes, ketones, or thio compounds.	*See* claim 10, above in this chart. Tomita: "[T]o solve the drawbacks of polyethylene sliding members . . . and to improve their wear resistance; as a result, they discovered that fatigue resistance can be dramatically improved by using **vitamin E group, as an oxidation inhibitor** . . . ." Ex. 1004 at [0007]. Tomita: "As **vitamin E group** to be used in the present invention, **vitamin E or a compound containing a vitamin E activity**

'710 Patent Claims	Tomita (Ex. 1004), Li (Ex. 1005) and Shen (Ex. 1006)
	can be used." Ex. 1004 at [0012]. Tomita: "Working Examples 1 to 3 After weighing 500 g of ultra-high molecular weight polyethylene . . . the prescribed amount of **vitamin E** . . . was measured and added." Ex. 1004 at [0029].

Claim 10 specifies that the polyethylene is either ultra high molecular weight polyethylene or high molecular weight polyethylene, and that the radiation is either gamma radiation or electron beam radiation. Claim 10 is met because Tomita teaches using ultra high molecular weight polyethylene (Ex. 1004 at [0029]), and irradiation by either gamma or electron beam (*id*. at [0021]). Claim 11 further recites that the antioxidant be selected from among a group that includes Vitamin E. Claim 11 is met because Tomita teaches using Vitamin E as the antioxidant. *Id*. at [0007, 0012, 0029].

Claims 12, 13, 14 and 15:

'710 Patent Claims	Tomita (Ex. 1004), Li (Ex. 1005) and Shen (Ex. 1006)
12. The method of claim 1, wherein providing an oxidation-resistant medical implant comprises: either (a) mixing the anti - oxidant and polyethylene powder and fusing the mixture to produce an oxidation-resistant preformed	*See* claim 1 in Section IX(A), above. Tomita: "In the manufacturing method of the present invention for a sliding member for artificial joints . . . that has **superior oxidation resistance** can be manufactured" Ex. 1004 at [0027]. Tomita: "[S]liding member for artificial joints can be manufactured by . . . **mixing the above described polyethylene, vitamin E group**, and, as needed, the other components . . . ." Ex. 1004 at [0015]. Tomita: "[W]hen manufacturing the present invention's sliding member for artificial joints; **any well-known molding method can be used**, such as **extrusion**

'710 Patent Claims	Tomita (Ex. 1004), Li (Ex. 1005) and Shen (Ex. 1006)
polyethylene and machining the oxidation-resistant implant from the oxidation-resistant preformed polyethylene or (b) mixing the anti-oxidant and the polyethylene powder and fusing the mixture in a mold to produce a direct molded oxidation-resistant medical implant; and packaging the oxidation-resistant implant in a sealed package.	**molding, compression molding, injection molding** . . . the molded product that is formed by these molding methods **can be used as-is** as the present invention's sliding member for artificial joints, or after molding **it can be further machined** . . . ." Ex. 1004 at [0019]. Shen: "Recently, several companies have modified the method of radiation sterilization to improve the wear resistance of UHMWPE components. This has typically involved **packaging the polyethylene cups** either in an inert gas (*e.g.*, Howmedica, Inc.), **in a partial vacuum** (*e.g.*, Johnson & Johnson, Inc.) or with an oxygen scavenger (*e.g.*, Sulzer Orthopaedics, Inc.)." Ex. 1006 at 5:8-14. Shen: "Furthermore, it is preferable that the radiation sterilization be done while **the final product** (*e.g.*, ***in vivo* implant**) **is packed** in a suitable low-oxygen atmosphere (*e.g.*, **in partial vacuum**, in an inert gas such as nitrogen, or with an oxygen scavenger included) in order to minimize oxidation of the surface layer of the final product during and after sterilization by irradiation." Ex. 1006 at 11:51-12:23.
13. The method of claim 12, wherein the irradiating the oxidation-resistant medical implant is performed while the implant is packaged in the sealed package.	*See* claim 12, above in this chart. Shen: "Furthermore, it is preferable that the radiation **sterilization be done while the final product** (*e.g.*, ***in vivo* implant**) **is packed** in a suitable low-oxygen atmosphere (*e.g.*, **in partial vacuum**, in an inert gas such as nitrogen, or with an oxygen scavenger included) in order to minimize oxidation of the surface layer of the final product during and after sterilization by irradiation." Ex. 1006 at 11:51-12:23.
14. The method of claim 12, wherein once the oxidation resistant medical implant is packaged in the sealed package, and the oxidation-	*See* claim 12, above in this chart. Shen: "Furthermore, it is preferable that the radiation **sterilization be done while the final product** (*e.g.*, ***in vivo* implant**) **is packed** in a suitable low-oxygen atmosphere (*e.g.*, **in partial vacuum**, in an inert gas such as nitrogen, or with an oxygen scavenger included) in order to minimize oxidation of the surface layer of the

'710 Patent Claims	Tomita (Ex. 1004), Li (Ex. 1005) and Shen (Ex. 1006)
resistant implant remains in the sealed package until the implant is to be implanted.	final product during and after sterilization by irradiation." Ex. 1006 at 11:51-12:23.
15. The method of claim 12, wherein packaging the oxidation-resistant medical implant comprises packaging the oxidation-resistant medical implant in an airtight package in an oxygen reduced atmosphere.	*See* claim 12, above in this chart. Shen: "Recently, several companies have modified the method of radiation sterilization to improve the wear resistance of UHMWPE components. This has typically involved **packaging the polyethylene cups either in an inert gas** (*e.g.*, Howmedica, Inc.), **in a partial vacuum** (*e.g.*, Johnson & Johnson, Inc.) **or with an oxygen scavenger** (*e.g.*, Sulzer Orthopaedics, Inc.)." Ex. 1006 at 5:8-14. Shen: "Furthermore, it is preferable that the radiation sterilization be done while **the final product** (*e.g.*, ***in vivo* implant**) **is packed in a suitable low-oxygen atmosphere** (*e.g.*, **in partial vacuum**, **in an inert gas such as nitrogen, or with an oxygen scavenger included**) in order to minimize oxidation of the surface layer of the final product during and after sterilization by irradiation." Ex. 1006 at 11:51-12:23.

Claim 12 has the same manufacturing limitations of claim 8, and adds the limitation that the implant is packaged in a sealed package. As explained above, Tomita alone (Ex. 1004 at [0015], [0019], [0027]), or in view of Li (Ex. 1005 at 1:26-56), renders all of the limitations of claim 8 obvious. The additional limitation of claim 12 is met in view of Shen, which teaches packaging polyethylene implants "in a partial vacuum." Ex. 1006 at 5:8-14; 11:51-12:23. A POSA would have understood that a partial vacuum can be maintained only by sealing the package. Ex. 1009 at ¶ 77.

Claim 13 specifies that the irradiation must be done while the implant is in the sealed package, and is met by the combination of Tomita, Li and Shen, as Shen teaches sterilization "done while the final product (*e.g.*, *in vivo* implant) is packed . . . in partial vacuum." Ex. 1006 at 11:51-12:23.

Claim 14 recites that the implant remains in the sealed package until it is to be implanted. It would have been obvious to a POSA to keep the implant in the sealed package until its implantation because a POSA would have understood the need to maintain the implant's sterility and protect it from potential oxidation through exposure to oxygen. Ex. 1009 at ¶ 79.

Claim 15 further specifies that the implant must be packaged in an airtight package in an oxygen reduced atmosphere. Claim 15 is met because Shen teaches packaging the implant in a "low-oxygen atmosphere (*e.g.*, in partial vacuum, in an inert gas such as nitrogen, or with an oxygen scavenger included)." Ex. 1006 at 11:51-12:23.

The packaging limitations of claims 12-15 also would have been obvious to a POSA in view of the general knowledge of a POSA prior to the '710 patent's earliest priority date. A POSA would understand that once an implant had been sterilized by irradiation, it is critical to maintain its sterility to avoid infection in a patient once implanted, just as preventing oxidation of the implant enhances its performance. Ex. 1009 at ¶ 81. Placing an implant in a sealed package

accomplishes both aspects by limiting its exposure to impurities and oxygen in the environment, thereby maintaining sterility and limiting oxidation. *Id.* Sealing the implant in a package prior to irradiation (as in claim 13), using an airtight package (as in claim 15), and keeping the implant in the package right before its implantation (as in claim 14) are all obvious options to prolong the sterility and reduce the oxidation of the irradiated implant. *Id*.

Accordingly, claims 1-16 would have been *prima facie* obvious over Tomita in view of Li and Shen.

B. Ground 2: Claims 1-16 Are Obvious Over Lidgren In View Of Li And Shen.

Lidgren discloses a method for manufacturing artificial joint prostheses (Ex. 1007 at 12:9-11) resulting in "excellent wear resistance and a decreased degradation" (*id.* at 8:28-30). A POSA would have understood "decreased degradation" to mean decreased degradation via oxidation of the artificial joint. Ex. 1009 at ¶ 84. Lidgren further discloses adding an antioxidant (Ex. 1007 at 8:32-35), and irradiating the antioxidant doped polyethylene at doses from 0-200 kGy (0-20 Mrad) (*id.* at 12:18-26; 14:5-10).

Lidgren and its United States counterpart patent (U.S. Patent No. 6,448,315) were cited by the examiner during prosecution of the '710 patent as the basis of rejections for the claims of the '710 patent in Office Actions on August 19, 2008, May 12, 2009, February 8, 2010, December 16, 2010, September 2, 2011, and July

17, 2012. Lidgren was never considered in combination with Li (which was not of record during prosecution) or Shen as discussed herein.

A POSA would have had reason to combine the teachings of Lidgren with Li and Shen. All three references teach methods and processes for improving the wear resistance of artificial joints by irradiating the polyethylene material from which the joints are made. Ex. 1009 at ¶¶ 84-85. A POSA would have looked to Li to confirm that radiation dosages above 5 Mrads (and above 20 Mrads) could be used to improve the wear resistance of UHMWPE manufactured by the Lidgren method without negatively affecting other characteristics. *Id.* at ¶ 85. A POSA would have also looked to Li for additional information regarding the processing of UHMWPE into implants, including fabricating techniques, and to confirm that no thermal treatment after irradiation was required. *Id.*

A POSA looking to optimize the wear-resistance properties of Lidgren's implants would have looked to Shen's disclosure for the range of physical parameters indicative of reduced or non-detectable wear in artificial joints made of irradiated polyethylene. *Id.* at ¶ 86. A POSA would have understood that these ranges of physical properties are indicative of optimal wear performance of the implant, whether or not it contains an antioxidant. *Id.* In addition, a POSA would have looked to Shen for its disclosures on processing and packaging techniques. *Id.*

A POSA would have understood that the teachings of Li and Shen are applicable to improving the process disclosed in Lidgren, even though Li and Shen do not involve the addition of an antioxidant to the UHMWPE material. *Id.* at ¶ 87.

Claim 1:

'710 Patent Claims	**Lidgren (Ex. 1007), Li (Ex. 1005) and Shen (Ex. 1006)**
1. A method for producing a wear-resistant and oxidation-resistant medical implant of a joint prosthesis, said method comprising the steps of:	Lidgren: A "method of the invention [that] has excellent properties for the manufacturing of **implants**, especially **joint prostheses.**" Ex. 1007 at 12:9-11. Lidgren: "The implant of the invention has **excellent wear resistance and a decreased degradation** before and after implantation in the body." Ex. 1007 at 8:28-30. Lidgren: "The purpose of adding an antioxidant to UHMWPE is to **reduce oxidation** of the polymer during sterilization and post sterilization and thereby **decrease the wear** of the implant in the body." Ex. 1007 at 8:32-35.
(I) providing an oxidation-resistant medical implant of a joint prosthesis comprising a polyethylene component; and	Lidgren: "The **implant** of the invention has excellent wear resistance and a **decreased degradation** before and after implantation in the body." Ex. 1007 at 8:28-30. Lidgren: "The purpose of adding an antioxidant to **UHMWPE [Ultra High Molecular Weight Polyethylene]** is to **reduce oxidation** of the polymer during sterilization and post sterilization and thereby decrease the wear of the implant in the body." Ex. 1007 at 8:32-35.
(II) irradiating the oxidation-resistant medical implant at a radiation dose of above 5 Mrad to about 25 Mrad so as to crosslink the implant thereby improving its wear resistance, without thermally	Lidgren: "Example 2 UHMWPE doped with vitamin E at a concentration of 0.5 weight% was prepared and compression moulded to blocks. Sample rods of 3x3x10 mm were then machined out from the blocks and **were subjected to γ-irradiation at doses 0-200 kGy [20Mrads]**." Ex. 1007 at 14:5-10. Lidgren claims: Claim 16. A method as any of claims 1-15, characterized in that the antioxidant doped UHMWPE material is γ-irradiated at a dose of at least 2 Mrad. Claim 17. A method as in claim 16, characterized in that

'710 Patent Claims	**Lidgren (Ex. 1007), Li (Ex. 1005) and Shen (Ex. 1006)**
treating the implant to extinguish free radicals in the irradiated and crosslinked implant during or subsequent to irradiating the oxidation-resistant implant; wherein	the dose is at least 9 Mrad. Claim 20. An implant comprising antioxidant doped UHMWPE material prepared as any of claims 1-19. Claim 21. An implant as in claim 20, which is a joint prosthesis. Li: An invention "directed to a total joint replacement . . . comprising a shaped crosslinked article made from UHMWPE . . . with irradiation at a dose higher than **4 Mrads, preferably 5 Mrads, and most preferably less than 10 Mrads.**" Ex. 1005 at 3:15-20. Li: Dosages up to 50 Mrads: "At every dose from 2.5 **to 50 Mrads**, directly molded samples had higher toughness than the corresponding extruded [ ] sample. The increased toughness . . . is so significant that **it is possible to use a higher irradiation dose** . . . and still obtain a higher toughness value . . . ." Ex. 1005 at 4:40-46. Li: "**[N]o heating after irradiation is required**" and "**Heating** the irradiated material to the melting point of UHMWPE **is not desirable and can cause deleterious effects** . . . ." Ex. 1005 at 5:60-67.
[i] the oxidation-resistant implant contains an antioxidant rendering it resistant to oxidation caused by free radicals generated by the irradiation of step (II); and	Lidgren: "The purpose of **adding an antioxidant** to UHMWPE is **to reduce oxidation of the polymer** during sterilization and post sterilization and thereby decrease the wear of the implant in the body." Ex. 1007 at 8:32-35. Lidgren: "**Natural antioxidants** can react with radiation induced free radicals in the polymer thereby terminating the chain scission process and in this way **reduce the oxidation of the polymer**." Ex. 1007 at 9:5-8.
[ii] the irradiated oxidation-resistant implant possesses the characteristics of: a degree of	Lidgren: "Radiation crosslinking caused little or no change in yield strength, but, the ultimate strength elongation to failure and impact strength decreased with increasing radiation dose, indicating that an optimum crosslinking dose would be one which provides a substantial reduction in wear while **maintaining acceptable levels of other physical**

'710 Patent Claims	**Lidgren (Ex. 1007), Li (Ex. 1005) and Shen (Ex. 1006)**
swelling of between about 1.7 to about 3.6; a molecular weight between crosslinks of between about 400 to about 3,500 g/mol; and a gel content of between about 95% to about 99%.	**properties**." Ex. 1007 at 5:21-27. Shen: "The present invention discloses methods for enhancing the wear-resistance of polymers, the resulting polymers, and the ***in vivo*** **implants** made from such polymers" Ex. 1006 at Abstract. Shen: "[A]cetabular cups [implants] made from UHMWPE falling within a preferred range of these physical parameters have reduced or non-detectable wear. The **ranges of these physical parameters** include one or more of the following: a **degree of swelling of between about 1.7 to about 5.3; molecular weight between crosslinks of between about 400 to about 8400 g/mol; and a gel content of between about 95% to about 99%**." Ex. 1006 at 17:41-47. Shen: "The degree of swelling, average molecular weight between crosslinks, crosslink density and gel content are shown in Table 7." Ex. 1006 at 50:27-29; *see also* Ex. 1006 at Table 7 ("non-remelted" physical parameters of irradiated polyethylene).

The combination of Lidgren, Li and Shen meets every limitation of claim 1, and therefore renders it obvious. The preamble of claim 1 discloses a method for making wear resistant and oxidation resistant medical implants for joint prostheses. Lidgren discloses a "method of the invention . . . for the manufacturing of implants, especially joint prostheses" (Ex. 1007 at 12:9-11), that the "implant of the invention has excellent wear resistance and a decreased degradation" and that the purpose of adding an antioxidant is to "reduce oxidation" (*id*. at 8:28-35).

Limitation (I) of claim 1 requires the joint prosthesis to be comprised of a polyethylene component, and is met by Lidgren's disclosure that "[t]he purpose of

adding an antioxidant to UHMWPE [ultra high molecular weight polyethylene] is to reduce oxidation of the polymer . . . and thereby decrease the wear of the implant in the body." *Id*. at 8:32-35.

The combination of Lidgren and Li meets the irradiation limitation of claim 1. Limitation (II) of claim 1 requires irradiating the implant with a dose of "above 5 Mrad to about 25 Mrad" to crosslink the implant thereby improving its wear resistance. Lidgren irradiates the antioxidant doped polyethylene at doses from 0-200 kGy. Ex. 1007 at 14:5-10. A POSA would have understood that 0-200 kGy is equivalent to 0-20 Mrad. Ex. 1009 at ¶ 91. In addition, Lidgren's claim 17 recites a radiation dose of at least 9 Mrads. Further, Li discloses "a total joint replacement . . . comprising a shaped crosslinked article made from UHMWPE" (Ex. 1005 at 3:15-17), and further discloses a radiation range of 2.5-50 Mrad (*id*. at 4:40-46). The radiation dosages taught in Lidgren and Li overlap and/or encompass the dosage recited in claim 1, rending the claimed range *prima facie* obvious. *See Peterson*, 315 F.3d at 1330.

Limitation (II) in claim 1 further requires "without thermally treating the implant" during or subsequent to irradiation. Example 2 of Lidgren discloses a process by which UHMWPE is doped with Vitamin E, sample rods are then machined and are irradiated at doses from 0 to 20 Mrad. Ex. 1007 at 14:5-10. Example 2 does not disclose a thermal treatment step and, as explained above, a

negative limitation may be satisfied by silence in the prior art. *Clio USA,* IPR2013-00448, Paper 15, at 3-4; *see also Cheng*, No. 2007-0959, 5-6.

During prosecution, OH argued that Example 2 failed to disclose an "implant," and that a POSA reading Example 2 would have understood that thermal treatment was required. Ex. 1002 at 361-367. A POSA would have readily understood by reading the claims in Lidgren, however, that the antioxidant polyethylene of Lidgren, including the sample rods of Example 2, were to be used to make an implant, and that thermal treatment after irradiation was optional in Lidgren's process. Ex. 1009 at ¶ 93.

The claims of a prior art patent are part of its disclosure and can invalidate the challenged claims. *See Therasense, Inc. v. Becton, Dickenson & Co.*, 593 F.3d 1289, 1295 (Fed. Cir. 2010). In *Therasense*, the central question on obviousness was whether the prior art disclosed a sensor "without a membrane." *Id.* at 1294. The claims of the prior art patent at issue included claims that were silent as to the membrane, as well as a dependent claim that specifically recited a membrane. *Id.* at 1295. In affirming the judgment of the district court finding obviousness, the Federal Circuit relied on the difference in scope of the claims to show that the reference taught that the membrane feature was optional, thus rendering the claims obvious. *See id.* ("[t]he claims of the [prior art patent] are plainly directed in part to sensors without a membrane, as is made clear by the dependent claims that

specifically include a membrane as an additional feature of the device.").

Similarly, a review of Lidgren's claims makes it clear that thermal treatment is an optional step of the disclosed method. Lidgren's claims 16 and 17 recite an "antioxidant doped UHMWPE" that is gamma irradiated to at least 2 Mrad (claim 16) and to at least 9 Mrad (claim 17). These claims do not disclose or require thermal treatment of any kind during or after irradiation. By contrast, claims 18 and 19, which depend from claims 16 and 17, add the steps of raising the temperature of the antioxidant-polyethylene material after gamma irradiation (claim 18) to at least 80˚C (claim 19). Furthermore, claim 20 of Lidgren indicates that the antioxidant doped UHMWPE of claims 16 and 17 could be made into an "implant." A POSA reading Lidgren would have understood that thermal treatment was not required for the invention of claims 16 and 17, and that implants could be made from the polyethylene material of claims 16 and 17. Ex. 1009 at ¶ 94. As such, Lidgren alone meets the "without thermally treating the implant" requirement.

Further, Li discloses that "no heating after irradiation is required" and that such heating "can cause deleterious effects." Ex. 1005 at 5:60-67. A POSA reading Lidgren in view of Li would have understood that Lidgren's antioxidant doped polyethylene material should be made without thermal treatment to avoid the "deleterious effects" of such treatment. Ex. 1009 at ¶ 96.

Lidgren meets limitation [i] of claim 1, which requires the implant to contain an antioxidant rendering it resistant to oxidation caused by free radicals generated by the irradiation step. Lidgren teaches "[n]atural antioxidants can react with radiation induced free radicals in the polymer thereby terminating the chain scission process and in this way reduce the oxidation of the polymer." Ex. 1007 at 9:5-8.

Finally, the combination of Lidgren and Shen disclose all of the physical parameters of the implant in limitation [ii] of claim 1. Lidgren teaches that an optimum crosslinking dose of radiation provides a "substantial reduction in wear while maintaining acceptable levels of other physical properties." Ex. 1007 at 5:21-27. Shen teaches all of the physical properties set forth in limitation [ii] of claim 1: "degree of swelling of between about 1.7 to about 5.3; molecular weight between crosslinks of between about 400 to about 8400 g/mol; and a gel content of between about 95% to about 99%." Ex. 1006 at 17:41-47. Shen further teaches that such parameters can be achieved without thermal treatment after irradiation. Ex. 1006, Table 7 (disclosing ranges of physical parameters for non-remelted polyethylene, *i.e.*, without thermal treatment, that encompass the ranges of limitation (ii) of claim 1).

Thus, claim 1 would have been obvious to a POSA over Lidgren in view of Li and Shen.

Claims 2, 3, 6, 7 and 16:

'710 Patent Claims	Lidgren (Ex. 1007), Li (Ex. 1005) and Shen (Ex. 1006)
2. The method of claim 1, wherein the radiation dose is from above 5 Mrad to about 10 Mrad.	*See* claim 1 in Section IX(B), above. Lidgren: "[T]o further improve the wear resistance of UHMWPE or the implants, the antioxidant doped UHMWPE material may be subjected to γ- or β-radiation at a dose **above 2 Mrad, preferably above 9 Mrad** . . . ." Ex. 1007 at 12:18-21. Li: "[A] total joint replacement device or component . . . with irradiation at a dose higher than 4 Mrads, **preferably 5 Mrads, and most preferably less than 10 Mrads.**" Ex. 1005 at 3:15-20.
3. The method of claim 1, wherein the polyethylene is selected from the group consisting of: ultra high molecular weight polyethylene and high molecular weight polyethylene.	*See* claim 1 in Section IX(B), above. Lidgren: "[A]n improved method for the addition of an antioxidant to **UHMWPE [ultra high molecular weight polyethylene]** in order to obtain a homogenous mixture of ultra high molecular weight polyethylene and an antioxidant." Ex. 1007 at 7:17-20. Lidgren: "Example 1 **Ultra high molecular weight polyethylene** (0.75 g; UHMWPE) as a powder (particles) . . . . Vitamin E (1 g), which is a viscous dark amber oil, was then added . . . ." Ex. 1007 at 13:16-23.
6. The method of claim 1, wherein the irradiation is performed with radiation selected from the group consisting of: gamma radiation and electron beam radiation.	*See* claim 1 in Section IX(B), above. Lidgren: "In order to further improve the wear resistance of UHMWPE or the implants, the antioxidant doped UHMWPE material may be subjected to **γ- [gamma] or β- [electron beam] radiation** . . . ." Ex. 1007 at 12:18-20. Lidgren claims: Claim 16. "A method as any of claims 1-15, characterized in that the antioxidant doped UHMWPE material is **γ- [gamma] irradiated** at a dose of at least 2 Mrad."
7. The method of claim 1, wherein the irradiation also sterilizes the implant.	*See* claim 1 in Section IX(B), above. Lidgren: "**Sterilization by γ-[gamma] irradiation** has been the method of choice for implants since about 1980." Ex. 1007 at 4:24-25. Lidgren claims: Claim 16. "A method as any of claims 1-15, characterized in that the antioxidant doped UHMWPE

'710 Patent Claims	Lidgren (Ex. 1007), Li (Ex. 1005) and Shen (Ex. 1006)
	material is **γ- [gamma] irradiated** at a dose of at least 2 Mrad."
16. The method of claim 1, wherein oxidation-resistant medical implant is irradiated at a radiation dose of above 10 Mrad to about 25 Mrad.	*See* claim 1 in Section IX(B), above. Lidgren: "Example 2 UHMWPE doped with vitamin E at a concentration of 0.5 weight% was prepared and compression moulded to blocks. Sample rods of 3x3x10 mm were then machined out from the blocks and **were subjected to γ-irradiation at doses 0-200 kGy [20 Mrads]**." Ex. 1007 at 14:5-10. Li: "At every dose from 2.5 **to 50 Mrads**, directly molded samples had higher toughness than the corresponding extruded [ ] sample. The increased toughness . . . is so significant that **it is possible to use a higher irradiation dose** . . . and still obtain a higher toughness value . . . ." Ex. 1005 at 4:40-46. Li: "At least 6 samples (10x20x90mm) were irradiated at each of the following gamma irradiation doses: 2.5, 5, **10, 20, 50 Mrads**." Ex. 1005 at 7:1-3.

Claim 2 further specifies a radiation dose above 5 Mrad to about 10 Mrad. Lidgren teaches a radiation dose of "above 2 Mrad, preferably above 9 Mrad" (Ex. 1007 at 12:18-21), and Li discloses a radiation dosage of "preferably 5 Mrads, and most preferably less than 10 Mrads." Ex. 1005 at 3:15-20. The radiation dose in claim 2 overlaps with the ranges disclosed in Lidgren and Li, and is therefore, *prima facie* obvious over these references. *See Peterson*, 315 F.3d at 1330.

Claim 3 specifies that the polyethylene is selected from the group consisting of ultra high molecular weight polyethylene, or high molecular weight polyethylene, and is met because Lidgren discloses the use of ultra high molecular weight polyethylene. Ex. 1007 at 7:18-20; 13:16-23.

Claim 6 recites that the radiation is either gamma radiation or electron beam radiation, and is met because Lidgren teaches subjecting the UHMWPE to γ- radiation (gamma radiation) or β- radiation (electron beam radiation). Ex. 1007 at 12:18-20; Lidgren claim 16.

Claim 7 requires that the irradiation also sterilize the implant. Claim 7 is met because Lidgren discloses "[s]terilization by γ-irradiation has been the method of choice for implants since about 1980." Ex. 1007 at 4:24-25. Lidgren discloses a radiation dose of at least 2 Mrad. *Id.* at 12:18-21. A POSA would have understood that a radiation dose of at least 2 Mrad is sufficient to sterilize an implant. Ex. 1009 at ¶ 105.

Claim 16 limits claim 1 to a radiation dose of above 10 Mrads to about 25 Mrads. Lidgren teaches a radiation dose from 0 to 200 kGy (Ex. 1007 at 14:5-10), which is equivalent to 0-20 Mrad. Ex. 1009 at ¶ 106. In addition, Li discloses using radiation doses from "2.5 to 50 Mrads" (Ex. 1005 at 4:40-46), and samples irradiated at "10, 20, 50 Mrads." Ex. 1005 at 7:1-3. The radiation dose range claimed in claim 16 falls within the doses disclosed by Lidgren and Li. Thus, claim 16 is *prima facie* obvious in view of these references. *See Peterson*, 315 F.3d at 1330 (overlapping ranges are *prima facie* obvious).

Claims 4 and 5:

'710 Patent Claims	**Lidgren (Ex. 1007), Li (Ex. 1005) and Shen (Ex. 1006)**
4. The method of claim 1, wherein the anti-oxidant is selected from the group consisting of: vitamin A, vitamin C, vitamin E, phenols, aromatic amines, salts and condensation products of amines with aldehydes, ketones, or thio compounds, and salts and condensation products of aminophenols with aldehydes, ketones, or thio compounds.	*See* claim 1 in Section IX(B), above. Lidgren: "By mixing particles of UHMWPE with an antioxidant, preferably **vitamin E**, . . . UHMWPE doped with an antioxidant being obtained." Ex. 1007 at 7:32-8:2. Lidgren: "Examples of antioxidants which can be used in the method according to the invention include α- and δ-tocopherol; propyl, octyl, or dodecyl gallates; lactic, citric, and tartaric acids and their salts; as well as orthophosphates. **Preferably, the antioxidant is vitamin E**." Ex. 1007 at 9:8-12. Lidgren: "According to the invention UHMWPE powder is doped with an **antioxidant, preferably vitamin E**, by mixing the UHMWPE particles with an antioxidant . . . ." Ex. 1007 at 9:26-28.
5. The method of claim 4, wherein the anti-oxidant is vitamin E.	*See* claim 4, above in this chart.

Claim 4 adds the limitation of an antioxidant selected from among a group including Vitamin E. Claim 5 depends from claim 4, and specifies that the antioxidant is Vitamin E. These claims are met because Lidgren teaches the use of Vitamin E as an antioxidant. Ex. 1007 at 7:32-8:2; 9:8-12; 9:26-28. *See Atofina*, 441 F.3d at 999 ("an earlier species reference anticipates a later genus claim").

Claims 8 and 9:

'710 Patent Claims	**Lidgren (Ex. 1007), Li (Ex. 1005) and Shen (Ex. 1006)**
8. The method of claim 1, wherein the oxidation-resistant medical implant is produced	*See* claim 1 in Section IX(B), above. Lidgren: "UHMWPE powder is doped with an antioxidant, preferably vitamin E, **by**

'710 Patent Claims	**Lidgren (Ex. 1007), Li (Ex. 1005) and Shen (Ex. 1006)**
according to the process selected from the group consisting of: (a) mixing the anti-oxidant and polyethylene powder and fusing the mixture to produce an oxidation-resistant preformed polyethylene and machining the oxidation-resistant medical implant from the oxidation-resistant preformed polyethylene; and (b) mixing the anti-oxidant and the polyethylene powder and fusing the mixture in a mold to produce a direct molded oxidation-resistant medical implant.	**mixing the UHMWPE particles with an antioxidant . . . .**" Ex. 1007 at 9:26-28. Lidgren: "The UHMWPE powder doped with antioxidant is **compression molded** either **directly into implants or** into blocks, from which **implants are produced by mechanical processing, e g turning, etc**." Ex. 1007 at 12:10-14. Li: "**UHMWPE is commercially produced as a powder** . . . . The powder is **fabricated into devices by** one of three methods: (1) **extrusion** into bars **followed by machining** of the device and (2) **compression molding** into sheets **followed by machining** and (3) **direct compression molding**." Ex. 1005 at 1:26-62.
9. The method of claim 8, wherein the polyethylene is selected from the group consisting of: ultra high molecular weight polyethylene and high molecular weight polyethylene.	*See* claim 8, above in this chart. Lidgren: "[M]ethod for the addition of an antioxidant to **UHMWPE [ultra high molecular weight polyethylene]** in order to obtain a homogenous mixture of **ultra high molecular weight polyethylene** and an antioxidant." Ex. 1007 at 7:18-20; 13:16-18.

Claim 8 specifies two well-known methods of manufacturing a polyethylene implant. Ex. 1009 at ¶ 110. The combination of Lidgren and Li discloses all of the limitation of claim 8. Lidgren teaches mixing the "UHMWPE particles with an antioxidant" (Ex. 1007 at 9:26-28), and "compression molded either directly into implants or into blocks, from which implants are produced by mechanical processing, e g [sic] turning, etc." *(id.* at 12:10-14). A POSA would have understood the phrase "directly into implants" to mean direct molded implants that

require no machining, and would have understood the term "turning" to be a method of machining, which satisfy the "direct molded" and "machining" limitation in claim 8. Ex. 1009 at ¶ 110. Li also discloses fabricating UHMWPE by extrusion or compression molding followed by "machining," and "direct compression molding" an implant. Ex. 1005 at 1:26-62.

Claim 9 further recites that the polyethylene must be either ultra high molecular weight polyethylene or high molecular weight polyethylene, and is met because Lidgren teaches the use of ultra high molecular weight polyethylene. Ex. 1007 at 7:18-20; 13:16-18.

Claims 10 and 11:

'710 Patent Claims	**Lidgren (Ex. 1007), Li (Ex. 1005) and Shen (Ex. 1006)**
10. The method of claim 1, wherein the polyethylene is selected from the group consisting of: ultra high molecular weight polyethylene and high molecular weight polyethylene; and the irradiation is performed with radiation selected from the group consisting of: gamma radiation and electron beam radiation.	*See* claim 1 in Section IX(B), above. Lidgren: "[M]ethod for the addition of an antioxidant to **UHMWPE [ultra high molecular weight polyethylene]** in order to obtain a homogenous mixture of **ultra high molecular weight polyethylene** and an antioxidant." Ex. 1007 at 7:18-20; 13:16-18. Lidgren: "In order to further improve the wear resistance of UHMWPE or the implants, the antioxidant doped UHMWPE material may be subjected to **γ- [gamma] or β- [electron beam] radiation** . . . ." Ex. 1007 at 12:18-20. Lidgren claims: Claim 16. "A method as any of claims 1-15, characterized in that the antioxidant doped UHMWPE material is **γ- [gamma] irradiated** at a dose of at least 2 Mrad."
11. The method of claim 10, wherein the anti-oxidant is selected	*See* claim 10, above in this chart. Lidgren: "By mixing particles of UHMWPE with an **antioxidant, preferably vitamin E**, . . . UHMWPE

'710 Patent Claims	Lidgren (Ex. 1007), Li (Ex. 1005) and Shen (Ex. 1006)
from the group consisting of: vitamin A, vitamin C, vitamin E, phenols, aromatic amines, salts and condensation products of amines with aldehydes, ketones, or thio compounds, and salts and condensation products of aminophenols with aldehydes, ketones, or thio compounds.	doped with an antioxidant being obtained." Ex. 1007 at 7:32-8:2. Lidgren: "Examples of antioxidants which can be used in the method according to the invention include α- and δ-tocopherol; propyl, octyl, or dodecyl gallates; lactic, citric, and tartaric acids and their salts; as well as orthophosphates. **Preferably, the antioxidant is vitamin E**." Ex. 1007 at 9:8-12. Lidgren: "According to the invention UHMWPE powder is doped with an **antioxidant, preferably vitamin E**, by mixing the UHMWPE particles with an antioxidant . . . ." Ex. 1007 at 9:26-28.

Claim 10 adds the limitation of: 1) selecting from ultra high molecular weight polyethylene or high molecular weight polyethylene and 2) using either gamma or electron beam radiation. Claim 10 is met because Lidgren teaches using "ultra high molecular weight polyethylene" (Ex. 1007 at 7:18-20; 13:16-18), and using "γ- [gamma] or β- [electron beam] radiation" (*id*. at 12:18-20; Claim 16).

Claim 11 depends from claim 10, adding the limitation of an antioxidant selected from among a group that includes Vitamin E. Claim 11 is met because Lidgren teaches using Vitamin E as the antioxidant. *Id*. at 7:32-8:2; 9:8-12; 9:26-28.

Claims 12, 13, 14 and 15:

'710 Patent Claims	Lidgren (Ex. 1007), Li (Ex. 1005) and Shen (Ex. 1006)
12. The method of claim 1, wherein	*See* claim 1 in Section IX(B), above. Lidgren: "UHMWPE powder is doped with an

'710 Patent Claims	Lidgren (Ex. 1007), Li (Ex. 1005) and Shen (Ex. 1006)
providing an oxidation-resistant medical implant comprises: either (a) mixing the anti - oxidant and polyethylene powder and fusing the mixture to produce an oxidation-resistant preformed polyethylene and machining the oxidation-resistant implant from the oxidation-resistant preformed polyethylene or (b) mixing the anti-oxidant and the polyethylene powder and fusing the mixture in a mold to produce a direct molded oxidation-resistant medical implant; and packaging the oxidation-resistant implant in a sealed package.	antioxidant, preferably vitamin E, **by mixing the UHMWPE particles with an antioxidant** . . . ." Ex. 1007 at 9:26-28. Lidgren: "The UHMWPE powder doped with antioxidant is **compression molded** either **directly into implants or** into blocks, from which **implants are produced by mechanical processing, e g turning, etc**." Ex. 1007 at 12:11-14. Lidgren: "Finally, the implant having excellent wear resistance and markedly reduced degradation in the body **are packaged** and sterilized." Ex. 1007 at 12:15-17. Shen: "Recently, several companies have modified the method of radiation sterilization to improve the wear resistance of UHMWPE components. This has typically involved **packaging the polyethylene cups** either in an inert gas (*e.g.*, Howmedica, Inc.), **in a partial vacuum** (*e.g.*, Johnson & Johnson, Inc.) or with an oxygen scavenger (*e.g.*, Sulzer Orthopaedics, Inc.)." Ex. 1006 at 5:8-14. Shen: "Furthermore, it is preferable that the radiation sterilization be done while **the final product** (*e.g.*, ***in vivo* implant**) **is packed** in a suitable low-oxygen atmosphere (*e.g.*, **in partial vacuum**, in an inert gas such as nitrogen, or with an oxygen scavenger included) in order to minimize oxidation of the surface layer of the final product during and after sterilization by irradiation." Ex. 1006 at 11:51-12:23.
13. The method of claim 12, wherein the irradiating the oxidation-resistant medical implant is performed while the implant is packaged in the sealed	*See* claim 12, above in this chart. Lidgren: "Finally, the implant having excellent wear resistance and markedly reduced degradation in the body **are packaged and sterilized**." Ex. 1007 at 12:15-17. Shen: "Furthermore, it is preferable that the radiation **sterilization be done while the final product** (*e.g.*, ***in vivo* implant**) **is packed** in a suitable low-oxygen

'710 Patent Claims	**Lidgren (Ex. 1007), Li (Ex. 1005) and Shen (Ex. 1006)**
package.	atmosphere (*e.g.*, **in partial vacuum**, in an inert gas such as nitrogen, or with an oxygen scavenger included) in order to minimize oxidation of the surface layer of the final product during and after sterilization by irradiation." Ex. 1006 at 11:51-12:23.
14. The method of claim 12, wherein once the oxidation- resistant medical implant is packaged in the sealed package, and the oxidation-resistant implant remains in the sealed package until the implant is to be implanted.	*See* claim 12, above in this chart. Shen: "Furthermore, it is preferable that the radiation **sterilization be done while the final product** (*e.g.*, ***in vivo* implant**) **is packed** in a suitable low-oxygen atmosphere (*e.g.*, **in partial vacuum**, in an inert gas such as nitrogen, or with an oxygen scavenger included) in order to minimize oxidation of the surface layer of the final product during and after sterilization by irradiation." Ex. 1006 at 11:51-12:23.
15. The method of claim 12, wherein packaging the oxidation-resistant medical implant comprises packaging the oxidation-resistant medical implant in an airtight package in an oxygen reduced atmosphere.	*See* claim 12, above in this chart. Shen: "Recently, several companies have modified the method of radiation sterilization to improve the wear resistance of UHMWPE components. This has typically involved **packaging the polyethylene cups either in an inert gas** (*e.g.*, Howmedica, Inc.), **in a partial vacuum** (*e.g.*, Johnson & Johnson, Inc.) **or with an oxygen scavenger** (*e.g.*, Sulzer Orthopaedics, Inc.)." Ex. 1006 at 5:8-14. Shen: "Furthermore, it is preferable that the radiation sterilization be done while **the final product** (*e.g.*, ***in vivo* implant**) **is packed in a suitable low-oxygen atmosphere** (*e.g.*, **in partial vacuum**, **in an inert gas such as nitrogen, or with an oxygen scavenger included**) in order to minimize oxidation of the surface layer of the final product during and after sterilization by irradiation." Ex. 1006 at 11:51-12:23.

Claim 12 has the same manufacturing limitations of claim 8, and adds the

limitation that the implant is packaged in a sealed package. As explained above, Lidgren alone (Ex. 1007 at 9:26-28; 12:10-14), or in view of Li (Ex. 1005 at 1:26-62), renders all of the elements of claim 8 obvious. The additional limitation of claim 12 is obvious in view of Shen, which teaches packaging polyethylene in a sealed package with a partial vacuum. Ex. 1006 at 5:8-14; 11:51-12:23; Ex. 1009 at ¶ 116.

Claim 13 specifies that the irradiation must be done while the implant is in the sealed package, and is met by the combination of Lidgren, Li and Shen, as Shen teaches sterilization "done while the final product (*e.g.*, *in vivo* implant) is packed . . . in partial vacuum[.]" Ex. 1006 at 11:51-12:23.

Claim 14 recites that the implant remains in the sealed package until it is to be implanted. Claim 14 is met because it would have been obvious to a POSA to keep the implant in the sealed package up to implantation in order to maintain the implant's sterility to avoid infection after implantation, and to protect the implant from potential oxidation through exposure to oxygen. Ex. 1009 at ¶ 118.

Claim 15 further specifies that the implant must be packaged in an airtight package in an oxygen reduced atmosphere. Claim 15 is met because Shen teaches packaging the implant in a "low-oxygen atmosphere (*e.g.*, in partial vacuum, in an inert gas such as nitrogen, or with an oxygen scavenger included)[.]" Ex. 1006 at 11:51-12:23.

In addition, as explained in Section IX. A. above, placing an artificial implant in a low-oxygen sealed package (whether prior to or after irradiation) would have been obvious to a POSA in view of the general knowledge of a POSA prior to the earliest priority date of the '710 patent. Ex. 1009 at ¶ 120.

Accordingly, claims 1-16 would have been *prima facie* obvious over Lidgren in view of Li and Shen.

X. OBJECTIVE INDICIA OF NONOBVIOUSNESS

A fact finder "must consider all evidence of obviousness and nonobviousness before reaching a determination" of whether claims would have been obvious to a POSA. *Eurand, Inc. v. Mylan Pharms., Inc.*, 676 F.3d 1063, 1077 (Fed. Cir. 2012). In cases in which a strong showing of *prima facie* obviousness exists, even relevant secondary considerations supported by substantial evidence may fail to alter the primary conclusion of obviousness. *See, e.g., Leapfrog Enters. Inc. v. Fisher-Price Inc.*, 485 F.3d 1157, 1162 (Fed. Cir. 2007); *Wm. Wrigley Jr. Co. v. Cadbury Adams USA LLC*, 683 F.3d 1356, 1364-65 (Fed. Cir. 2012).

During prosecution of the '710 patent, OH submitted a declaration that purported to present evidence of secondary considerations of nonobviousness including long-felt need, commercial success, and unexpected results. Ex. 1002 at 261-68. The examiner dismissed OH's alleged evidence of long-felt need and

commercial success. Regarding "long-felt need," the examiner found that the declaration failed to present evidence of prior, unsuccessful attempts to solve the problem at issue. *Id.* at 234. The examiner found OH's "commercial success" arguments unpersuasive because they were based on predictions of how well particular implants will sell instead of "showing actually how commercially successful they are compared to other similar products on the market now." *Id.*

Although not commented on by the examiner, OH's purported evidence of unexpected results is also unpersuasive. Ex. 1009 at ¶¶ 122-23. OH submitted test results intended to show that DePuy's AOX polyethylene performed better than a prior art product also made by DePuy. But OH fails to explain how or why these results were unexpected. OH also fails to explain how these results — unexpected or not — relate to the features of the claimed invention.

OH also submitted test data relating to examples set forth in Tomita. Ex. 1002 at 267-68. The test data fails to show that the claimed invention of the '710 patent achieves any unexpected results over the prior art. Ex. 1009 at ¶ 123. A POSA reading Tomita in view of Shen would have readily understood and expected that obtaining the range of physical parameters in claim 1 of the '710 patent entails adjusting the amount of antioxidant and/or the radiation dose used. *Id.* at ¶ 124. In fact, Table 3 in OH's declaration (Ex. 1002 at 267) illustrates this understanding and expectation. *Id*.

Table 3

Sample No.	Vitamin E Concentration	Gamma Dose	Degree of Swelling Mean ± SD	Gel Content Mean ± SD	Molecular Weight between Crosslinks
1 (Tomita Example 2)	0.5%	2.5 Mrad (25 kGy)	6.06 ± 0.16	91.5 ± 0.8	11,300
2	0.5%	5 Mrad (50 KGy)	4.25 ± 0.04	94.0 ± 0.1	5,100
3	None	2.5 Mrad (25 kGy)	4.43 ± 0.06	94.0 ± 0.2	5,600
4 (Tomita Comparative Example 2)	None	5 Mrad (50 kGy)	3.52 ± 0.03	96.7 ± 0	3,200

Adjusting the radiation dose to achieve the physical parameters for a given amount of antioxidant is exemplified by the results of Samples 1 and 2 in Table 3 — the 0.5% antioxidant doped polyethylene. *Id*. Increasing the irradiation dose from 2.5 Mrad to 5 Mrad changed the physical parameters of the antioxidant doped polyethylene, *i.e.*, brought them closer to the physical parameters disclosed in claim 1 of the '710 patent. *Id*. A POSA would have understood that increasing the radiation dose further would yield the desired physical parameters. *Id*. Indeed, the specification of the '710 patent makes it clear that a POSA would have understood this fact. Ex. 1001 at 12:49-57, 13:9-15.

DePuy has demonstrated that the claims of the '710 patent are *prima facie* obvious over the cited prior art, and the patent disclosure and prosecution history are devoid of evidence of any secondary considerations of nonobviousness.

XI. CONCLUSION

Claims 1-16 of the '710 patent are rendered obvious over the prior art in the combinations cited herein. Petitioner has established a reasonable likelihood of prevailing on each ground, and prompt and favorable consideration of this Petition is respectfully requested.

Dated: December 30, 2014

RESPECTFULLY SUBMITTED,

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CERTIFICATION OF SERVICE (37 C.F.R. §§ 42.6(e), 42.105(a))

The undersigned hereby certifies that the above-captioned "PETITION FOR INTER PARTES REVIEW OF U.S. PATENT NO. 8,658,710 UNDER 35 U.S.C. §§ 311-319 AND 37 C.F.R. § 42.100, et seq.," including its supporting evidence (Exhibits 1001 — 1020), was served in its entirety on December 30, 2014, upon the following parties via overnight courier:

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