

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE PATENT TRIAL AND APPEAL BOARD

TRIENDA HOLDINGS, L.L.C.
Petitioner

v.

DESGAGNÉS, BROWN, ET ASSOCIÉS INC.
Patent Owner

Case IPR2021-01295

U.S. Patent No. 10,570,276

PETITION

FOR

INTER PARTES REVIEW

OF

U.S. PATENT NO. 10,570,276

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EXHIBIT LIST

The following Exhibit List is provided in accordance with 37 C.F.R.

§ 42.63(e):

Exhibit No.	Description
1001	U.S. Patent No. 10,570,276 (the “’276 Patent”)
1002	Declaration of Chris E. Scott, Ph.D.
1003	U.S. Patent Application Publication No. 2008/0114131 (“Harris”)
1004	U.S. Patent No. 7,601,423 (“Nakayama”)
1005	Richard W. Thomas and David Cuttino, <i>Performance of Corrugated Pipe Manufactured with Recycled Polyethylene Content</i> , NAT’L ACADS. OF SCIENCES, ENG’G, AND MED. (2011) (“Thomas”)
1006	U.S. Patent Application Publication No. 2005/0004316 (“Starita”)
1007	Andrew J. Peacock, HANDBOOK OF POLYETHYLENE, STRUCTURES, PROPERTIES, AND APPLICATIONS chs. 1, 2, 7 (Marcel Dekker, 2000) (“Peacock”)

1008	U.S. Patent Application Publication No. 2013/0090400 (“Robert”)
1009	U.S. Patent No. 6,221,982 (“Debras”)
1010	U.S. Patent No. 8,445,607 (“Slawinski”)
1011	U.S. Patent No. 6,579,922 (“Laurent”)
1012	ASTM D4976 “Standard Specification for Polyethylene Plastics Molding and Extrusion Materials” (2012)
1013	U.S. Patent Application Publication No. 2003/0171492 (“Starita ’492”)
1014	Leszek A. Utracki, <i>Polyethylenes and Their Blends</i> , 2 POLYMER BLENDS HANDBOOK 1559–732 (Leszek A. Utracki & Charles A. Wilkie, eds., Springer Reference, 2d ed. 2014); Francesco Paolo La Mantia and Roberto Scaffaro, <i>Recycling Polymer Blends</i> , 3 POLYMER BLENDS HANDBOOK 1885–913 (Leszek A. Utracki & Charles A. Wilkie, eds., Springer Reference, 2d ed. 2014) (“Utracki”)

1015	Paul Miller, Igor Sbarski, Pio Iovenitti and Syed Masood, <i>Rheological Properties of Blends of Recycled HDPE and Virgin Polyolefins</i> , 6 POLYMER RECYCLING 181–86 (2001) (“Miller”)
1016	International Publication No. WO 2012/139967 (“Duranel”)
1017	European Patent No. EP 3406666 (“Trolez”)
1018	Notice of Allowance in Application No. 16/027,460
1019	M. R. Thompson, C. Xi, E. Takacs, M. Tate and J. Vlachopoulos, <i>Experiments and Flow Analysis of a Micropelletizing Die</i> , 44 POLYMER ENG’G AND SCIENCE 1391 (July 2004) (“Thompson”)
1020	U.S. Patent No. 7,696,287 (“Siraux”)
1021	Charles A. Harper, HANDBOOK OF PLASTICS AND ELASTOMERS, ch. 1 (McGraw-Hill Book Company, 1975)
1022	Gregory W. Kamykowski, <i>Rheology of Polyethylene</i> , HANDBOOK OF INDUSTRIAL POLYETHYLENE AND TECHNOLOGY (Mark A. Spalding & Ananda M. Chatterjee eds., John Wiley & Sons, Inc. 2018) (Oct. 2017)

1023	U.S. Patent No. 9,340,629 (“Bhandarkar”)
1024	U.S. Patent No. 3,516,841 (“Haveman”)
1025	U.S. Patent Application Publication No. 2005/0261435 (“Starita ’435”)
1026	Michael C. Restaino, <i>Polyethylene, Introduction</i> , HANDBOOK OF PLASTIC MATERIALS AND TECHNOLOGY 311–16 (Irvin I. Rubin ed., John Wiley & Sons Inc., 2014)
1027	UNIVAL™ DMDA-6320 NT 7 Data Sheet
1028	Harold P. Grace, <i>Dispersion Phenomena In High Viscosity Immiscible Fluid Systems And Application Of Static Mixers As Dispersion Devices In Such Systems</i> , 14 CHEM. ENG’G COMMC’NS 225-277 (1982)
1029	M. Sánchez-Soto, A. Rossa, A. J. Sánchez, J. Gámez-Pérez, <i>Blends of HDPE Wastes: Study of the Properties</i> , 28 WASTE MANAGEMENT 2565–73 (2008)
1030	Fred W. Billmeyer, TEXTBOOK OF POLYMER SCIENCE 62–104 (Wiley-Interscience, 2d. ed., 1971)

I. SUMMARY OF THE ARGUMENT

Under 35 U.S.C. §§311–319 and 37 C.F.R. §42.100 *et seq.*, Petitioner Trienda Holdings, L.L.C. requests *inter partes* review of claims 1–15 of U.S. Patent No. 10,570,276 (Ex. 1001).

Polyethylene is one of the most widely used and well-understood polymer resins. For decades, manufacturers have recognized the need to balance the cost and processability of a resin composition with the final product’s mechanical properties. To optimize this balance, manufacturers have been selecting and blending polyethylene resins with specific characteristics for decades.

Adjusting well-known variables to determine an optimum workable range is not inventive. Yet, the limitations purportedly distinguishing the claims of the ’276 Patent are directed solely to the adjustment of well-known variables. Specifically, the ’276 Patent claims merely recite ranges for well-known variables that indicate mechanical properties (e.g., molecular weight and density) and ranges for other well-known variables that indicate processability (e.g., melt index, melt flow rate, particle size distribution). Not only does the prior art disclose these specific ranges, but anyone in the industry would have understood how and why to change these variables to achieve the desired product properties while ensuring that the resin composition can be processed using standard equipment.

II. MANDATORY NOTICES, STANDING, AND FEES

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

The real parties-in-interest are: (i) Trienda Holdings, L.L.C., (ii) Penda Corporation, (iii) The Pendaform Company, (iv) Kruger Family Industries, LLC, and (v) Kruger Family Holdings II, LLC.

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

The '276 Patent is involved in a pending lawsuit, *Brown v. Kruger Family Holdings, II, LLC*, Case No. 4:20-cv-00278-JFH-FHM (N.D. Okla.), which may be affected by a decision in this proceeding. Brown has accused Trienda of infringing claims 1, 13 and 15 of the '276 Patent. Claims 1–15 are at issue in this Petition.

U.S. Patent No. 10,894,877 (the "'877 Patent") claims priority to the '276 Patent, so the outcome here may affect the '877 Patent.

Additionally, U.S. Patent Application No. 17/118,659 claims priority to the '276 Patent and may be affected by a decision in this proceeding.

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

Petitioner provides the following designation of counsel, to which all correspondence should be addressed. Petitioner consents to electronic service.

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A power of attorney appointing the above lead and back-up counsel accompanies this Petition.

D. Standing.

The '276 Patent is available for IPR having been filed on July 5, 2018 and issued on February 25, 2020. Petitioner is not barred or estopped from requesting review of claims 1–15 of the '276 Patent on the grounds identified in this Petition.

E. Payment of Fees.

The required fee has been paid from Deposit Account No. 170055, and the Office is authorized to deduct any additional fees due with this Petition.

III. RELIEF REQUESTED

Petitioner requests review of claims 1–15 of the '276 Patent on the following grounds:

Ground	Proposed Statutory Rejections for the '276 Patent
1	Claims 1–15 are obvious under 35 U.S.C. §103 in view of Harris and Nakayama.
2	Claims 1–15 are obvious under 35 U.S.C. §103 in view of Thomas, Starita, and Nakayama.

The references listed in the preceding table are prior art under 35 U.S.C. §102(a)(1) because each reference is a patent or printed publication published before the '276 Patent's claimed priority date of July 5, 2018. The references are analogous art to the '276 Patent because they each relate to polyethylene resins or compositions.

IV. BACKGROUND

A. Polyethylene Has Been Widely Used Due To The Recognized Ability To Manufacture Resins Having Greatly Diverse Properties.

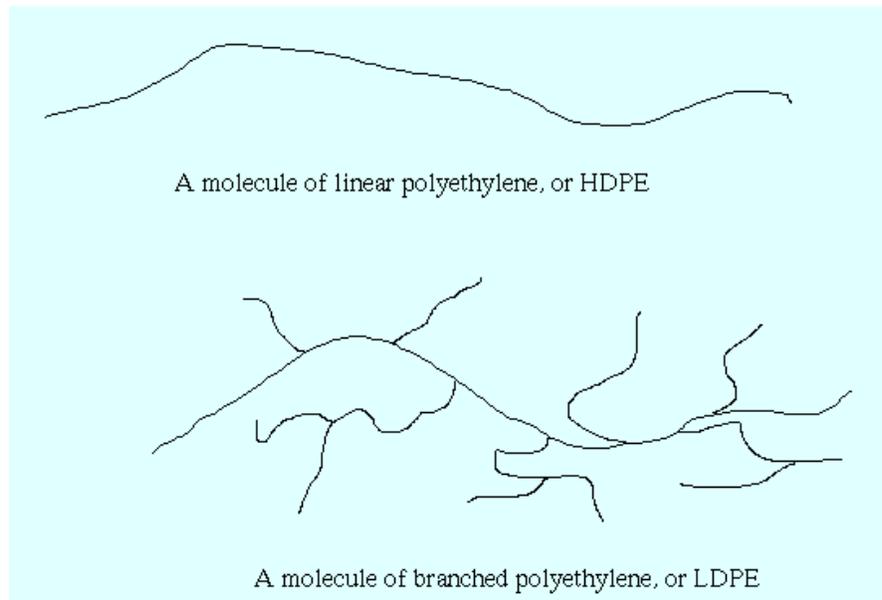
Polyethylene resins are a class of polymers (long-chain molecules) derived primarily from ethylene. (Ex. 1002 ¶43.) The polymerization reaction can create resins of different composition, molecular weight, branching type, branching distribution, and density. (*Id.* ¶44.) Polyethylene's processability and properties depend on its composition, molecular structure, and molecular weight. (*Id.* ¶45.)

The first commercial polyethylene resins were sold over 80 years ago. (Ex. 1007 p.28–29.) These first products were composed of low-density polyethylene (LDPE) and were used as electrical insulators. (*Id.*) In the 1940s, researchers discovered that polyethylene’s branching structure greatly affected its physical properties. (*Id.* p.30.) This discovery allowed manufacturers to predictably control the mechanical properties of the products by varying the polymerization conditions. (*Id.*)

In the following ten years, the range of products made from polyethylene expanded dramatically. (*Id.*) By varying the polymerization conditions, manufacturers could create products that had desirable mechanical properties. (*Id.* p.30–31.) For example, manufacturers seeking to create films, such as shrink-wrap, could selectively manufacture clear, flexible polyethylene resins, while those seeking to create blow-molded bottles could selectively manufacture products that had high degrees of toughness and impact resistance. (*Id.* p.31.)

Despite these advantages, inherent material limitations prevented polyethylene from entering many commercial markets. (*Id.*) The polyethylene products created using the methods known in the 1940s were low in tensile strength, deformed gradually, and cracked in hostile environments. (*Id.* p.32–33.) Researchers attributed these limitations to the high degree of short-chain branching in LDPE. (*Id.*)

The discovery of high-density polyethylene (HDPE) in the 1950s allowed polyethylene to enter new markets. (*Id.* p.37.) Researchers discovered a way to catalyze the polymerization reaction to form molecules having negligible branching. (*Id.* p.34–35.) The figure below depicts the difference between HDPE with negligible branching and LDPE with branching. This new HDPE exhibited many properties that were superior to LDPE, including stiffness and strength. (*Id.* p.38.)



Although HDPE had many advantages over LDPE, it was challenging to process. HDPE is more viscous than LDPE, which requires more energy to mold the resin through, for example, an extruder. (*Id.* p.38.) Additionally, the low crystallinity in HDPE yields more shrinkage while molding products. (*Id.*)

From the 1950s onward, research into polyethylene sought to balance mechanical properties and processability by creating specialized polyethylene resins for particular applications. (*Id.*) Researchers were able to produce polyethylene resins with densities in the range of 0.91–0.96 g/cm³. (*Id.*) This broad range of densities allowed manufacturers to select a density yielding the desired degree of mechanical properties, such as stiffness, while also having acceptable degrees of processability. (*Id.* p.32.) Children’s toys and paint buckets are examples of common commercial items produced with stiff yet processable HDPE. (Ex. 1002 ¶42.)

Continued research allowed manufacturers to tailor the properties of polyethylene resins by controlling for the molecular weight distribution of polyethylene resins. Molecular weight describes a polyethylene molecule’s size, which indicates the length of the chain of ethylene monomers. (Ex. 1007 p.7.) Because polyethylene molecules can form chains of varying lengths, polyethylene can range from low molecular weight to ultrahigh molecular weight. (Ex. 1002 ¶46; Ex. 1007 pp.1, 7.) The molecular weight (and, by extension, the chain length) affects properties such as viscosity, environmental stress cracking, and impact strength. (*Id.* p.7.) For example, LDPE typically has lower molecular weight and is particularly suitable for applications such as trash bags. (*Id.* p.24.) On the other end of the spectrum, the unique properties of HMWPE provide it with exceptional

toughness, impact strength, and wear resistance, making it particularly suitable for machine parts and orthopedic implants. (Ex. 1008 ¶0002.)

By the 1990s, researchers discovered how to narrow the molecular weight distribution to create resins having properties tailored for the end use. (Ex. 1007 p.41.) But there were significant limitations. For example, researchers discovered that too narrow of a molecular weight distribution changed the resins' viscosity and thus affected the processability. (*Id.*)

In the 1990s, researchers identified a means of combining the desirable attributes of resins having distinct molecular weight distributions using new tandem reactor polymerization technology. This technology allowed manufacturers to create polyethylene resins having bimodal molecular weight distributions. (Ex. 1011 3:15–33.) A bimodal resin has a molecular weight distribution that includes substantial portions with both lower molecular weight molecules and higher molecular weight molecules. (Ex. 1002 ¶48.) These bimodal resins benefit from having the strength and stiffness of a high-density polyethylene, while retaining the high-stress-crack resistance and processability of unimodal medium-density grades. (Ex. 1009 1:21–43.)

B. Blending Polyethylene Resins Allows For Further Tailoring Of Processability And Performance Properties.

Additionally, polyethylene performance and processability properties have been tailored by blending multiple resins since at least 1846. (Ex. 1013; Ex. 1014

pp.1583–85, 1616–22.) By taking advantage of properties including density, melt flow index, molecular weight distribution and modality, individual polyethylene resins can be combined by melt blending to create compositions having the desired properties. (*Id.*) Another advantage of using a melt-blended composition is that commodity grade resins, including virgin, recycled, scrap, and wide specification resins, can be employed in a blended composition without impairing the properties of the product, instead of requiring a specially polymerized premium cost resin. (Ex. 1002 ¶54.) This can result in significant cost savings. (*Id.*)

Financial and environmental factors favor incorporating recycled materials in polymer resin blends. (*See* Ex. 1015 pp.181–82 (Blends of virgin and recycled polymer resins have been known since at least 2001 to enable and improve re-use of post-consumer recycled (PCR) or post-industrial recycled (PIR) materials.)) PCR and PIR materials can be recycled into new items, rather than being landfilled or burned, and these materials are often cheaper than virgin resins. (Ex. 1002 ¶55; Ex. 1006 ¶0004.) Despite these advantages, using recycled materials presented challenges such as the presence of impurities and the potential for detrimental changes in the molecular structure due to the recycling process. Researchers began focusing on different avenues for addressing these challenges. By the mid-2000s, researchers had discovered that blending virgin polyethylene with recycled polyethylene can result in mechanical properties comparable to that of virgin

polyethylene. (Ex. 1014 pp.1899–1900.) By 2012, it was established that blending recycled resins with virgin resins often reduces detrimental components and their effects on the final properties. (Ex. 1016 12:28–14:24.) Thus, a PHOSITA knew that blending virgin with recycled resins provides the cost-benefit of recycled resins without losing the performance properties of virgin resins. (Ex. 1002 ¶¶57–59.)

C. Optimization Of Polyethylene Properties.

The creation of a polyethylene composition requires a manufacturer to make a number of decisions each of which has advantages and drawbacks. (Ex. 1002 ¶¶90.) As a result, manufacturers engage in an optimization process where the manufacturer must make a series of tradeoffs to achieve the suitable end properties of the product and suitable processability of the resins, while minimizing cost. (Ex. 1006 ¶¶0004, 0012–13.) For example, a pipe manufacturer may want to select a high molecular weight resin that would create a pipe having superior strength and stiffness; but if the resin used to create such a pipe is too viscous to process commercially, the manufacturer may need to select a resin having a somewhat lower molecular weight, sacrificing some strength and stiffness in exchange for more affordable processability. (*See id.*) As another example, a manufacturer that would prefer the lower cost of recycled resins has a countervailing interest in minimizing product defects; such a manufacturer may elect to blend recycled

resins with more expensive virgin resins in a manner that balances concerns for affordability with concerns for reliability. (Ex. 1002 ¶¶88–90; Ex. 1017 ¶¶0002–08.)

In addition to blending resins to optimize properties, it has been known for decades to blend additives, such as antioxidants, into polyethylene compositions. The presence of oxygen in processing and post-processing can cause oxidative degradation of polyethylene. (Ex. 1007 p.385.) Adding antioxidants can reduce the degradation effects. (*Id.*; *see also* Ex. 1005 p.6.)

V. **OVERVIEW OF THE ALLEGED INVENTIONS.**

A. **The '276 Patent Describes Non-Inventive Ranges For Well-Known Properties Of Polyethylene Resin Mixtures Without Discussing Unexpected Results.**

Against this crowded background, the '276 Patent issued with 15 claims related to polyethylene compositions, products, and processes, three of which are independent. Independent claim 1 relates to a composition, independent claim 13 relates to a product comprising the composition, and independent claim 15 relates to a process for preparing a product using the composition.

Claim 1, which is representative of the composition and exemplary of the other independent claims, recites the following:

1. A composition comprising:

i) a first virgin polyethylene resin, having a bimodal molecular weight distribution which is high molecular weight (HMW), having a high load melt index measured according ASTM D-1238 (HLMI) of from about 1 to 6 g/10 min; and comprising a particle size distribution of less than about 50 μm ;

ii) a second virgin polyethylene resin, an HLMI from about 20-70 g/10 min, a melt flow index measured according ASTM D-1238 (MFI) of from about 0.20-0.60 g/10 min, and comprising a particle size distribution of less than about 50 μm ;

iii) a first post-consumer polyethylene resin, having a MFI of from about 0.10-0.70 g/10 min;

iv) a second post-consumer polyethylene resin, which is HMW, and having a HLMI of from about 4-8 g/10 min; and

v) a polyethylene antioxidant.

(Ex. 1001 7:20–41.) The composition is a blend of four resins and an antioxidant.

(Ex. 1002 ¶31.) The composition includes two HMW resins, where one is virgin and one is post-consumer recycled. (*Id.*) The composition also includes two resins of unspecified molecular weight, where one is virgin and one is post-consumer recycled. (*Id.*) The two HMW resins have lower melt indices than the unspecified resins and thus a higher viscosity. (*Id.*)

Claims 13 and 15 do not include any limitations that differ materially from the limitations of claim 1. For example, claim 13 recites a “polyethylene product comprising a composition” that is the same composition claimed in claim 1. While the ’276 Patent discloses generic products that could be prepared using the claimed composition, including extruded films, blown film, cast film, and pellets, it does not describe any products for which the composition would be particularly useful or advantageous. (Ex. 1001 5:51–65.) Claim 15 recites a “process for preparing a polyethylene product.” The process includes the steps of providing the same composition as claim 1, blending the resins and antioxidant, and melting and shaping the blend. The ’276 Patent does not ascribe any novelty to, or identify advantages of, this process but instead admits that “blown film, cast film and extruded sheet processes are known to skilled persons in the art.” (Ex. 1001 5:50–56.) Thus, to the extent claim 1 is deemed invalid, the same conclusion is necessarily true of claims 13 and 15.

B. The Prosecution History Was Minimal.

The ’276 Patent issued without rejection. In the reasons for allowance, the Examiner identified U.S. Publication No. 2017/0107364 as showing the state of the art but distinguished the reference on the grounds that it did not provide guidance about the two recycled resins and their respective HLMI and for not disclosing particle sizes. (Ex. 1018 p.2–3.) However, substantial prior art not before the

Examiner establishes that employing two post-consumer recycled resins in a resin blend where resins have the claimed HLMI and particle sizes was well-known in the art and would have been obvious to a PHOSITA. Further, none of the references relied on in grounds 1 and 2 were considered by the Examiner during prosecution. Thus, the Board should institute this IPR because the Office has not considered the art or arguments presented in this Petition.

VI. PRINCIPLES OF LAW

A claim is unpatentable if the subject matter, as a whole, would have been obvious at the time of the invention to a PHOSITA. *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 406 (2007). When a patent claims a combination of elements already known in the art, that patent is obvious if, at the time of the alleged invention, a PHOSITA would have had a reason to combine those known elements in the manner claimed. *See id.* at 416–18. A reason to combine can be found in the “interrelated teachings of multiple patents; the effects of demands known to the design community or present in the marketplace; and the background knowledge possessed by a person having ordinary skill in the art.” *Id.* at 418.

Routine experimentation can provide a motivation to modify a prior art disclosure. “[W]here the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation.” *E.I. DuPont de Nemours & Co. v. Synvina C.V.*, 904 F.3d 996,

1006 (Fed. Cir. 2018) (internal quotation omitted). A “*prima facie* case of obviousness typically exists when the ranges of a claimed composition overlap the ranges disclosed in the prior art.” *In re Peterson*, 315 F.3d 1325, 1329 (Fed. Cir. 2003). Where a claimed range overlaps with a range disclosed in the prior art, there is a presumption of obviousness. *E.I. DuPont*, 904 F.3d at 1006. Under this presumption, “the burden of production falls upon the patentee to come forward with evidence of teaching away, unexpected results, or other pertinent evidence of nonobviousness.” *Id.*

Similarly, “discovery of an optimum value of a result effective variable in a known process is ordinarily within the skill of the art.” *In re Boesch*, 617 F.2d 272, 276 (C.C.P.A. 1980). “A recognition in the prior art that a property is affected by the variable is sufficient to find the variable result-effective.” *In re Applied Materials, Inc.*, 692 F.3d 1289, 1297 (Fed. Cir. 2012). “[T]he prior art need not provide the exact method of optimization for the variable to be result-effective.” *Id.* And “[t]he mere fact that multiple result-effective variables were combined does not necessarily render their combination beyond the capability of a person having ordinary skill in the art.” *Id.* at 1298.

For example, in *DuPont*, the Federal Circuit reversed the Board and held claims invalid as obvious even though the claims included limitations not specifically set forth in the prior art. 904 F.3d at 1013. The claims related to a

method for producing a chemical compound and recited reactor conditions including a specific temperature range and a specific pressure. *Id.* at 999. The prior art references disclosed “appropriate or preferred temperatures and air pressures for the reaction, indicating that persons of ordinary skill understood that the reaction was affected by temperature and pressure.” *Id.* Because the prior art demonstrated that a PHOSITA would understand that varying the temperature and pressure would affect the claimed reaction, temperature and pressure were result-effective variables, and it would have been known that an optimal workable range could be determined by manipulating these variables. *Id.* Thus, even though the prior art ranges differed from the claimed ranges, the claims were obvious because discovery of an optimum value of a result effective variable in a known process is ordinarily within the skill of the art. *Id.*

VII. THE LEVEL OF SKILL IN THE ART.

A person having ordinary skill in the art at the time of the invention is a person having a bachelor’s degree in chemical engineering or mechanical engineering and three years of experience in blending polymer resins, or equivalent work experience. (Ex. 1002 ¶36.)

VIII. CLAIM CONSTRUCTION.

The term “particle size distribution” may warrant construction. Claims 1, 7, 8, 13, and 15 recite a resin having a certain “particle size distribution” ranging

from about 1 to 50 μm . In the polyethylene resin art, a resin's "particle size" can describe the size of two different particles.

First, "particle size" may refer to the size of the resin particles formed after the polymerization process that are used in a manufacturing process, such as pellets. Molten resin is extruded through a pelletizer, which creates pellets that may be transported and used in further processing. (Ex 1019 p.1391.)

Second, "particle size" may refer to the size of the primary particles or grains in a produced polyethylene resin. (Ex. 1020 1:47–57.) In the polymerization process, the polymer is produced in a reactor in the presence of a catalyst. (*Id.*) Primary particles grow around a catalyst core. These primary particles formed in the reactor must be melted, homogenized, and extruded before they are sold. (*Id.*) Primary particles tend to agglomerate or clump in the reactor. (*Id.*) The collection of individual primary particles and agglomerated primary particles is called fluff. (*Id.*)

The intrinsic evidence demonstrates that "particle size" references the primary particle size, not the size of the resin pellets. The '276 Patent explains that resins comprise "a particle size distribution of less than about 30 μm ." (Ex. 1001 3:1–4.) The '276 Patent further explains that the resins "may comprise a proportion of particles having a size greater than 50 microns (called an agglomerates and are usually created by accident in the reactor)." (*Id.* 3:5–8.) In

other words, the '276 Patent is explaining that the particles should be less than about 30 μm , but the reactor can create agglomerations of these particles, such agglomerations having sizes greater than 50 μm . By referencing the particles in the reactor, the '276 Patent demonstrates that particle size distribution refers to the primary particles created in the reactor, not the post-polymerization or pellet size. (Ex. 1002 ¶¶39–40.) Nevertheless, as discussed below, claims 1–15 are invalid under either interpretation.

Petitioner's claim construction position in this proceeding is not a concession as to the proper scope of any claim term in any litigation or a waiver of any argument that any claim is invalid as indefinite.

IX. CLAIMS 1–15 ARE UNPATENTABLE.

The claims are not inventive but instead merely identify characteristics of a polyethylene composition created through routine optimization. As the prior art discloses, it is routine for a PHOSITA to select a polyethylene resin based on its properties, such as strength and stiffness, blend this highly viscous resin with a lower viscosity resin to improve processability, incorporate recycled resins having similar properties as the first two resins to reduce cost, and optimize the resins' particle size distribution to achieve the final product's desired consistency and homogeneity and further to include an antioxidant.

This Petition identifies two unpatentability grounds. Ground 1 relies on Harris as a primary reference. Harris discloses a method for producing melt blended polyethylene compositions and products. Harris discloses combining up to six or more individual resins and describes as exemplary resins having density, molecular weight, HLMI, and MFI properties within the claimed ranges. To the extent Harris does not explicitly disclose the claimed particle size distribution, Ground 1 relies on Nakayama.

Ground 2 relies on Thomas as a primary reference. Thomas discloses an exemplary four-resin blend that includes two virgin resins and two recycled resins. To the extent Thomas does not disclose that the four resins have properties in the claimed ranges, Starita's disclosure of exemplary resins having the same properties as the claimed resins renders the claims obvious. This ground also relies on Nakayama to prove the particle size distribution limitation would have been obvious.

A. Result-Effective Variables

For all claims and grounds discussed below, the prior art establishes that all six of the following claimed variables are result-effective variables: (1) density; (2) molecular weight; (3) modality and molecular weight distribution; (4) melt flow; (5) particle size distribution; and (6) ratio of recycled to virgin content. Changes to

these variables are known in the art to affect the processability of the resin, the end product's mechanical properties, and/or the cost of production.

(1) *Density*. Since at least 1975, textbooks have described the main density classifications. (Ex. 1021 p.89.) At least as early as 2004, the classification of polyethylene resins was standardized by international organizations by ASTM. (Ex. 1002 ¶49.) The identification by density is summarized below. (*Id.*)

Description	Density Range
Low Density	0.910 – 0.925
Medium Density	> 0.925 – 0.940
High Density	> 0.940

The prior art recognized that increasing the density results in higher strength and stiffness but also lower ductility and increased processing difficulties. (Ex. 1007 pp.30–32; Ex. 1002 ¶¶66–67.) The density of a resin can be altered by changing the branching/crystallinity formed during polymerization. (Ex. 1007; Ex. 1002 ¶66.)

(2) *Molecular weight*. Since at least 2008, prior art recognized that increasing the molecular weight improves certain physical properties of a resin such as ESCR. (Ex. 1009 1:10–23; Ex. 1006 ¶¶0008–0011; Ex. 1002 ¶70.) Further, prior art recognized that higher molecular weight resins are more difficult and more expensive to process. (Ex. 1009 1:21–43; Ex. 1003 ¶0034; Ex. 1002 ¶70.)

(3) *Modality and molecular weight distribution.* Varying the molecular weight distribution to attain multimodal resins, such as bimodal resins, which include LMW and HMW fractions, enhances the resins' physical properties while improving processability. (Ex. 1011; Ex. 1002 ¶¶71–75.) For example, ESCR of bimodal HMW HDPE is increased as compared to the unimodal HMW HDPE having similar melt flow properties. (Ex. 1006 ¶0035.) The modality and distribution is tailored by adjusting catalyst features, catalyst systems, or reactor conditions. (Ex. 1010 1:46–2:2; Ex. 1002 ¶75.)

(4) *Melt flow and melt index.* A resin's melt flow and melt index relate to the ease of processing the resin in, for example, an extruder. The results of changing melt flow index (MFI) and high load melt index (HLMI) have been known since at least 2008 when patent applications described blending resins to improve melt flow properties. (Ex. 1003 ¶¶0029–30; Ex. 1002 ¶77.) Lower HLMI or MFI indicates higher viscosity and higher molecular weight, improving certain mechanical properties of the end product but making it more difficult to process the resin. (Ex. 1003 ¶0027; Ex. 1002 ¶78.) Higher HLMI or MFI indicates lower viscosity and lower molecular weight, reducing certain mechanical properties while easing processability. (*Id.*) Changing the resin's molecular weight during polymerization changes the resin's melt flow properties. (*Id.*)

(5) *Particle size distribution.* It has been known since at least 2013 that the particle size used in a melt blend impacts the ease of homogenization and prevalence of defects when the resin is processed in the melt state. (Ex. 1010 2:43–54, 4:54–67.) Thus, reducing particle size distribution can increase the homogeneity of resin blends when melt blending resins. (*Id.*; Ex. 1002 ¶¶79, 87.) Reducing particle size also increases homogenization during extrusion. (*Id.*; Ex. 1020 2:57–61.)

Additionally, the primary particle size influences aspects of the polymerization process such as reactor stability, ease of reactor operation, flow in the reactor, slurry transfer between reactors, and separation of residual components. (Ex. 1023 1:49–60, 4:4–51.) Primary particle size can be controlled by adjusting catalyst particle size and reactor residence time. (*Id.* 2:25–39; Ex. 1002 ¶¶82–83.)

(6) *Recycled-to-Virgin Ratio.* The recycled-to-virgin ratio in a polyethylene blend is a result-effective variable because the amount of recycled resin reduces the product's cost but has the potential to impair its quality and mechanical properties. (Ex. 1003 ¶¶0005, 0037.) A PHOSITA knew to optimize the ratio of virgin to recycled resin to achieve the desired cost savings at tolerable reduction of these mechanical properties. (Ex. 1005 pp.24–28; Ex. 1003 ¶¶0005, 0037; Ex. 1002 ¶¶88–90.)

The prior art has established that one or more properties are affected by each of these six variables. Because the '276 Patent lacks any disclosure of what is novel, surprising, or unexpected about the claimed ranges of these variables, discovering the optimum values of any of these variables is *prima facie* obvious. *Boesch*, 617 F.2d at 276.

B. Ground 1: Claims 1–15 Are Obvious In View Of Harris And Nakayama.

1. Claims 1, 7, and 8.

(a) Harris's Relevant Disclosures.

Harris discloses a method for selecting and blending polyethylene resins to achieve a composition having properties within the '276 Patent's claimed ranges. (Ex. 1003 ¶¶0005, 0010.) Harris explains that an advantage of blending resins is that manufacturers can achieve significant cost savings by using commodity grade resins, including virgin, recycled, and wide specification resins, instead of specially polymerized, premium cost HDPE. (*Id.* ¶0005.) While Harris's preferred embodiment relates to drainage pipes, Harris discloses that these same methods apply to other plastic articles, such as extruded films or sheets. (*Id.* ¶0019.)

Like the claimed invention, Harris discloses that a polyethylene composition may include four HDPE polyethylene resins (referred to hereafter as resins (i) through (iv)). (Ex. 1003 ¶0038.) Regarding resin (i), Harris discloses a first virgin polyethylene resin. (*Id.* ¶0033 (“HMW-HDPE”); ¶0035.) Resin (i) has a bimodal

molecular weight distribution which is high molecular weight (HMW). (*Id.* ¶¶0031, 0033.) Resin (i) further has an HLMI within the range of from about 1 to 6 g/10 min. (*Id.* ¶0029.)

Regarding resin (ii), Harris discloses a second virgin polyethylene resin. (*Id.* ¶0033 (“H-HDPE”); ¶0035.) Resin (ii) has a melt flow index measured according to ASTM D-1238 (MFI) within the range of from about 0.20-0.60 g/10 min. (*Id.* ¶0033.) Harris discloses that resin (ii) has an FRR (ratio of HLMI to MFI) of “about 20 to about 200,” which equates to an HLMI within the range from about 20–70 g/10 min. (*Id.* ¶0029; Ex. 1002 ¶¶76, 132.)

Regarding resin (iii), Harris discloses first post-consumer polyethylene resin. (Ex. 1003 ¶0035; Ex. 1002 ¶¶136–37.) Resin (iii) has an MFI within the range of from about 0.10–0.70 g/10 min. (Ex. 1003 ¶0033; Ex. 1002 ¶138.)

Regarding resin (iv), Harris discloses a second post-consumer polyethylene resin, which is HMW. (*Id.* ¶0033 (“HMW-HDPE”); ¶0035; Ex. 1002 ¶¶139–40.) Resin (iv) has a HLMI within the range of from about 4–8 g/10 min. (Ex. 1003 ¶0029.)

Harris further discloses incorporating a polyethylene antioxidant into the compositions. (*Id.* ¶¶0044–0045.)

Harris also discloses examples that render the claims obvious. Harris’s Example 2 teaches a polyethylene composition similar to the claimed composition.

(Ex. 1003 ¶¶0057.) The composition includes a first high molecular weight resin. (*Id.* ¶¶0059 (“40% HMW-HDPE”).) Harris discloses that any of the resins can be virgin resins and thus teaches that the first resin is a virgin resin. (*Id.* ¶¶0035; Ex. 1002 ¶¶125.) Harris discloses that the resins can be bimodal and thus teaches that the first resin is bimodal. (Ex. 1003 ¶¶0031.) Harris further teaches HMW-HDPE having an HLMI of 4.5 g/10 min. (*Id.* ¶¶0029.)

In Example 2, Harris teaches a second resin. (*Id.* ¶¶0058 (“40% H-HDPE”).) Harris discloses that any of the resins can be virgin resins and thus teaches that the second resin is a virgin resin. (*Id.* ¶¶0035.) Harris discloses that the H-HDPE resins have a preferred MFI of 0.3 to about 1.0 g/10 min. (*Id.* ¶¶0033.) Harris further discloses that the resins should have a FRR (the ratio of HLMI to MFI) of preferably about 90 to 130. (*Id.* ¶¶0029.) By disclosing MFI between 0.3 and 1.0 and FRR between 90 and 130, Harris teaches a PHOSITA that the HLMI is between 27 and 130 g/10 min. (Ex. 1002 ¶¶132.)

Harris discloses that the resins are “selected from the group consisting of virgin, recycled, scrap and wide specification resins, and mixtures thereof.” (Ex. 1003 ¶¶0009.) Based on the well-known advantages of blending virgin with recycled resins to reduce cost while maintaining performance, a PHOSITA would recognize that the H-HDPE resin in Example 2 may be a mixture of virgin and post-consumer recycled resins having substantially similar properties. (Ex. 1002

¶¶136–37; Ex. 1016 pp.12–14.) As a result, Harris teaches a first post-consumer polyethylene resin having a MFI from about 0.10 to 0.70 g/10 min. (Ex. 1003 ¶0033.)

Similarly, based on Harris’s disclosure of the group the resins are selected from, a PHOSITA would recognize that the HMW-HDPE resin in Example 2 may be a mixture of virgin and post-consumer recycled resins having substantially similar properties. (Ex. 1002 ¶139–40.) As a result, Harris teaches a second post-consumer polyethylene resin, which is HMW, having an HLMI of about 4–8 g/10 min. (*Id.*)

Harris further discloses that antioxidants are common additives. (Ex. 1003 ¶0045.) As a result, a PHOSITA would recognize that Example 2 would include an antioxidant. (Ex. 1002 ¶143.)

Based on the express disclosures in Harris’s detailed description and Example 2, a PHOSITA would immediately envisage the four-resin polyethylene composition containing an antioxidant having all of the claimed properties except the claimed particle size distribution, which is not explicitly disclosed in Harris. (Ex. 1002 ¶114.) As a result, other than the particle size distribution limitations, no additional obviousness analysis for elements i–v is required.

Nevertheless, based on Harris’s disclosure and the extensive knowledge in the art of resin blending, a PHOSITA would have found it obvious to create a four-

resin blend, as claimed, with a reasonable expectation of success. (Ex. 1002 ¶115; *see also* Ex. 1005 p.33, Table 8 (B3).) Harris expressly contemplates four resins by disclosing that the composition may include “one to about 6 or more individual LLDPEs, LMDPEs, H-HDPEs, and/or HMW-HDPEs.” (Ex. 1003 ¶0038.) A PHOSITA would have selected a first virgin polyethylene resin that has a bimodal molecular weight distribution that is high molecular weight and has a low HLMI because such resins typically have enhanced mechanical properties, such as impact resistance and ESCR. (Ex. 1002 ¶115.) Given the low HLMI, it would have been obvious to a PHOSITA to blend the first resin with a second polyethylene resin that has a higher HLMI and MFI to increase the processability of the composition. (Ex. 1002 ¶115.)

Based on the well-known advantages of blending virgin with recycled resins to reduce cost while maintaining performance, it would have been obvious to blend a third post-consumer recycled resin having properties similar to the second resin because it would reduce the cost of using virgin resin alone. (*Id.* ¶116; Ex. 1003 ¶¶0005, 0037.) Similarly, it would have been obvious to a PHOSITA to use a fourth resin which is post-consumer recycled resin having a high molecular weight and low HLMI because the fourth resin would provide similar properties as the first resin while offsetting the cost of using virgin resin. *Id.* A PHOSITA would have had a reasonable expectation of success in replacing the single resins with

resin blends because the resin properties can be adjusted by adjusting the proportions of each resin in the blend. (Ex. 1017 ¶¶0040–0068; Ex. 1002 ¶116.)

Incorporating an antioxidant would have been obvious because antioxidants are commonly added to prevent oxidation and the degradative effects associated with oxidation. (Ex. 1003 ¶¶0044–0045; Ex. 1002 ¶117.)

In addition, claimed ranges for HLMI and MFI would have been obvious because they are result-effective variables. The disclosures in Harris overlap with the claimed ranges:

Variable	Claim 1	Harris
first virgin PE resin HLMI	about 1 to 6 g/10 min	4.5 g/10 min
second virgin PE resin HLMI	about 20–70 g/10 min	FRR of about 20 to about 200, preferably about 90 to about 130.
second virgin PE resin MFI	about 0.20–0.60 g/10 min	0.1 to about 1.5, preferably about 0.3 to about 1.0
first PCR PE resin MFI	about 0.10–0.70 g/10 min	0.1 to about 1.5, preferably about 0.3 to about 1.0,

Second PCR PE resin	about 4–8 g/10 min	4.5 g/10 min
HLMI		

(b) Nakayama’s Disclosures.

Nakayama discloses a method for preparing polyethylene resins where the particle size distribution is less than 25 μm . (Ex. 1004 at Abstract.) Nakayama discloses a method of producing polyethylene primary particles having a median diameter (d_{50}) between 3 and 25 μm . (*Id.*; *id.* 7:38–59.) Nakayama discloses that the polyethylene particles have a narrow particle size distribution. (*Id.* 6:11–16.) Nakayama also discloses a most preferred embodiment where 100% of the particles pass through a mesh screen having an opening of 37 μm . (*Id.* 7:22–37.) A PHOSITA would understand these disclosures to teach a “particle size distribution of less than about 50 μm ” and within the range of 1–30 μm , as claimed. (Ex. 1002 ¶129–30.)

To the extent “particle size” references the particles input into the manufacturing equipment, such as an extruder, Nakayama also discloses adding particles having a median diameter (d_{50}) between 3 and 25 μm into manufacturing equipment, including in extrusion processes. (*Id.* 7:38–59, 47:50–63.)

(c) A PHOSITA would have reason to modify Harris in light of Nakayama.

A PHOSITA would have found it obvious to modify the Harris composition such that the first and second virgin resins would be in the form of microparticles having a median diameter between 3 and 25 μm , as taught by Nakayama. (Ex. 1002 ¶118.) As Nakayama explains, “[i]n recent years, polymer microparticles are actively developed and widely used for various industrial applications.” (Ex. 1004, 1:31–38.) When resins are not homogeneously mixed, the final product may have undesirable properties or flaws due to high concentration pockets of a single resin lacking the properties of the blend. (Ex. 1010 4:54–68.) To avoid undesirable properties or flaws, a PHOSITA would want to increase homogenization. (Ex. 1002 ¶¶118–19) Because a PHOSITA would have understood that the size of particles influences homogenization, a PHOSITA would have been motivated to incorporate the particles of Nakayama because they are smaller and have desirable flowability and bulk density and, therefore, are easier to mix and more likely to distribute homogeneously. (Ex. 1002 ¶118; Ex. 1004 3:15–20.) A PHOSITA would have selected microparticles to increase homogeneity without doing anything inventive.

In addition, a PHOSITA understood that resins with high viscosity differences are difficult to mix and thus difficult to blend homogeneously. (Ex. 1002 ¶87.) Based on knowledge in the art related to particle size and resin

blending, a PHOSITA would have understood that it would have been desirable to minimize the resins' particle size to increase the ease of mixing and homogeneity, particularly in light of the high HLMI differences between the resins disclosed in Harris. (*Id.*)

A PHOSITA would have further recognized that Nakayama's microparticles can be used in a manufacturing process, such as a melt-blend extrusion process. (*Id.* ¶120.) For example, Nakayama discloses that the microparticles can be relatively easily handled and can be used safely in a working environment. (Ex. 1004 7:45–59.) Nakayama further discloses that the microparticles are suitable for conventional molding processes, such as extrusion molding. (*Id.* 47:50–63.) As a result, a PHOSITA combining Nakayama with Harris would have had a reasonable expectation of success in incorporating the microparticles in an extrusion process.

Additionally, because particle size distribution is a result effective variable and because Nakayama's disclosed range overlaps with the claimed range, the claimed range is presumed obvious. *E.I. DuPont*, 904 F.3d at 1006. Further, it would have been obvious to optimize the particle size distribution to achieve the desired homogenization, flowability, and bulk density.

As shown below, Harris and Nakayama disclose every limitation of claims 1, 7, and 8. (Ex. 1002 ¶¶121–43, 154–55.)

'276 Patent	Harris and Nakayama
[1.0] A composition comprising:	<p>“A polyethylene composition is provided that has a density of about 0.945 to about 0.960 g/cm³ and a melt flow index of about 0.1 to about 0.4.” (Ex. 1003, Abstract)</p> <p>“A feature of the invention compositions is that more than one LLDPE, LMDPE, H-HDPE, and/or HMW-HDPE, each having individual ranges of density, MFI and/or FRR and/or modalities, can be employed to increase the flexibility by which components can be melt-blended together in order to achieve the desired physical characteristics of the resulting composition.” (<i>Id.</i> ¶0038.)</p>
[1.1] i) a first virgin polyethylene resin,	<p>“The resins are independently selected from the group consisting of virgin, recycled, scrap and wide specification resins, and mixtures thereof.” (<i>Id.</i> ¶0032)</p> <p>“For example, it is possible to use combinations of resins that include...one to about 6 or more individual LLDPEs, LMDPEs, H-HDPEs, and/or HMW-HDPEs.” (Ex. 1003, ¶0038)</p> <p>“HMW-HDPE” (<i>Id.</i> ¶0033.)</p>
[1.2] having a bimodal molecular weight distribution	<p>“The LLDPE, LMDPE and HDPE resins used in the composition, methods, and articles according to the invention, can be unimodal, bimodal, multimodal, or mixtures of these types.” (<i>Id.</i> ¶0031)</p>
[1.3] which is high molecular weight (HMW),	<p>“A suitable HMW-HDPE for use in the melt blends according to the invention has a weight average molecular weight of about 100,000 to about 1,000,000 daltons.” (<i>Id.</i> ¶0026, Fig. 7)</p> <p>“HMW-HDPE” (<i>Id.</i> ¶0033.)</p>

'276 Patent	Harris and Nakayama
[1.4] having a high load melt index measured according ASTM D-1238 (HLMI) of from about 1 to 6 g/10 min;	“The FRR is the ratio of the high load melt index (HLMI, condition F at 21.6 kg at 190° C.) to the melt index (MI, condition E at 2.16 kg and 190° C.). For example, an LLDPE or a LMDPE with a nominal MI of 0.7 and a HLMI of 21.0 would have an FRR (HLMI/MI=21.0/0.7) of about 30. HMW-HDPE having an HLMI of 4.5 and an MI of 0.05 would have an FRR of about 90....Polyethylene resins suitable for use in the invention compositions can have a FRR of about 20 to about 200, preferably about 90 to about 130.” (<i>Id.</i> ¶0029)
[1.5] and comprising a particle size distribution of less than about 50 µm	<p>The median diameter (d_{50}) of the ethylene-based polymer microparticles of the present invention is $3\ \mu\text{m} \leq d_{50} \leq 25\ \mu\text{m}$, and preferably $3\ \mu\text{m} \leq d_{50} \leq 10\ \mu\text{m}$. (Ex. 1004 at 7:42–45.)</p> <p>When the ethylene-based polymer microparticles of the present invention are classified using a vibrating sieve or an ultrasonic vibration sieve, the fraction of particles passing through a mesh screen having an opening of 37 µm (Tyler #400) is not less than 95 wt %, more preferably not less than 98 wt %, furthermore preferably not less than 99.7%, and most preferably 100%. (<i>Id.</i> at 7:23–30.)</p> <p>For the molded article of the present invention, the ethylene-based polymer microparticles or functional group-containing ethylene-based polymer microparticles of the present invention are molded into desired shape without deteriorating properties...For example, molded articles with desired shape can be obtained by injection molding, extrusion molding, or press molding. According to the required property of molded article, another resin may be used together, or various additives may also be mixed when molded. (<i>Id.</i> at 47:50–63.)</p>
[1.6] ii) a second virgin polyethylene resin,	“For example, it is possible to use combinations of resins that include, for example but not limited to, one to about 6

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	<p>or more individual LLDPEs, LMDPEs, H-HDPEs, and/or HMW-HDPEs.” (Ex. 1003, ¶0038)</p> <p>“H-HDPE” (<i>Id.</i> ¶0033)</p> <p>“Any or all of the LLDPE and/or the LMDPE and the HDPE resins in the embodiments of the invention melt blended compositions can be recycled, wide specification, scrap and/or virgin resin, with mixtures of these source resins being typical.” (<i>Id.</i> ¶0035)</p>
<p>[1.7] an HLMI from about 20-70 g/10 min,</p>	<p>“Polyethylene resins suitable for use in the invention compositions can have a FRR of about 20 to about 200, preferably about 90 to about 130.” (<i>Id.</i> ¶0029)</p> <p>“In an embodiment of the invention, the HDPE can be selected from the group consisting of a..., a homopolymer high density polyethylene resin. (H-HDPE) having a melt flow index of about 0.1 to about 1.5.” (<i>Id.</i> ¶0008.)</p>
<p>[1.8] a melt flow index measured according ASTM D-1238 (MFI) of from about 0.20-0.60 g/10 min,</p>	<p>“The HDPE resin can be selected from the group consisting of...H-HDPE having a melt flow index of about 0.1 to about 1.5, preferably about 0.3 to about 1.0, and mixtures thereof.” (<i>Id.</i> ¶0033)</p>
<p>[1.9] and comprising a particle size distribution of less than about 50 µm;</p>	<p><i>See</i> [1.5].</p>
<p>[1.10] iii) a first post-consumer polyethylene resin,</p>	<p>“In the foregoing embodiments, the resins can be independently selected from the group consisting of virgin, recycled, scrap and wide specification resins, and mixtures thereof.” (<i>Id.</i> ¶0009)</p> <p>“Any or all of the LLDPE and/or the LMDPE and the HDPE resins in the embodiments of the invention melt</p>

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	<p>blended compositions can be recycled, wide specification, scrap and/or virgin resin, with mixtures of these source resins being typical.” (<i>Id.</i> ¶0035)</p> <p>“For example, such recycled or scrap products may include, but are not limited to, such usable resins obtained as ‘milk jugs’ produced from H-HDPE, ‘T-shirt bags’ constructed from bimodal HMW HDPE, recycled 55 gallon drums constructed from HMW HDPE....” (<i>Id.</i> ¶0028)</p> <p>“H-HDPE” (<i>Id.</i> ¶0033)</p>
<p>[1.11] having a MFI of from about 0.10-0.70 g/10 min;</p>	<p>“The HDPE resin can be selected from the group consisting of HMW-HDPE resin having a melt flow index of about 0.01 to about 0.2, preferably about 0.05 to about 0.15, and H-HDPE having a melt flow index of about 0.1 to about 1.5, preferably about 0.3 to about 1.0, and mixtures thereof.” (<i>Id.</i> ¶0033)</p> <p>“Polyethylene resins suitable for use in the invention compositions can have a FRR of about 20 to about 200, preferably about 90 to about 130.” (<i>Id.</i> ¶0029)</p>
<p>[1.12] iv) a second post-consumer polyethylene resin,</p>	<p>“In the foregoing embodiments, the resins can be independently selected from the group consisting of virgin, recycled, scrap and wide specification resins, and mixtures thereof.” (<i>Id.</i> ¶0009)</p> <p>“Such recycled or scrap products may include, but are not limited to, such usable resins obtained as ‘milk jugs’ produced from H-HDPE, ‘T-shirt bags’ constructed from bimodal HMW HDPE, recycled 55 gallon drums constructed from HMW HDPE, plastic dry cleaning bag material made of LLDPE, and the like.” (<i>Id.</i> ¶0028)</p> <p>“Any or all of the LLDPE and/or the LMDPE and the HDPE resins in the embodiments of the invention melt</p>

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	<p>blended compositions can be recycled, wide specification, scrap and/or virgin resin, with mixtures of these source resins being typical. In particular, the use of recycled, wide specification and/or scrap resins is very economical in comparison to the use of virgin resins. Suitable virgin, scrap, recycled and wide specification LLDPE, H-HDPE, and HMW-HDPE are known in the art.” (<i>Id.</i> ¶0035)</p> <p>“HMW-HDPE” (<i>Id.</i> ¶0033.)</p>
<p>[1.13] which is HMW,</p>	<p>“A suitable HMW-HDPE for use in the melt blends according to the invention has a weight average molecular weight of about 100,000 to about 1,000,000 daltons.” (<i>Id.</i> ¶0026, Fig. 7)</p> <p>“HMW-HDPE” (<i>Id.</i> ¶0033.)</p>
<p>[1.14] and having a HLMI of from about 4-8 g/10 min; and</p>	<p>“HMW-HDPE having an HLMI of 4.5 and an MI of 0.05 would have an FRR of about 90. Both of these materials would be considered to have a narrow molecular weight distribution and low polydispersity. Polyethylene resins suitable for use in the invention compositions can have a FRR of about 20 to about 200, preferably about 90 to about 130.” (Ex. 1003, ¶0029)</p> <p>“HMW-HDPE having an HLMI of 4.5” (<i>Id.</i> ¶0029)</p>
<p>[1.15] v) a polyethylene antioxidant.</p>	<p>“The compositions according to the invention may also comprise other additives customary for use in resin-based compositions, according to the application for which they are being used. Such additives include...antioxidants...” (<i>Id.</i> ¶0045)</p>
<p>7. The composition of claim 1, wherein said first and second virgin polyethylene</p>	<p><i>See</i> [1.5].</p>

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resin is each independently comprising a particle size distribution of less than about 30 μm .	
8. The composition of claim 1, wherein said first and second virgin polyethylene resin is each independently comprising a particle size distribution of from about 1 to 30 μm .	<i>See</i> [1.5].

2. Claim 2.

Harris discloses that each of the first virgin polyethylene resin, second virgin polyethylene resin, first post-consumer recycled resin, and second post-consumer recycled resin are a HDPE. (Ex. 1003 ¶¶0038.) Harris also discloses that suitable virgin and recycled H-HDPE and HMW-HDPE are known in the art. (*Id.* ¶¶0035.) As a result, a PHOSITA would recognize that Harris teaches a four-resin blend of HDPE where two resins are virgin and two resins are post-consumer recycled. (Ex. 1002 ¶¶136–37, 144–45.)

In Example 2, both resins are identified as high-density polyethylene. (Ex. 1003 ¶¶0058–0059.) As discussed above, a PHOSITA would have recognized or, at minimum, it would have been obvious to a PHOSITA, that a portion of each

identified resin could be a mixture of virgin and post-consumer recycled resins having substantially similar properties. (Ex. 1002 ¶¶136–37.) As a result, Harris’s Example 2 discloses or renders obvious this limitation.

To the extent Harris does not explicitly disclose that the first virgin polyethylene resin, second virgin polyethylene resin, first post-consumer recycled resin, and second post-consumer recycled resin are high-density polyethylene, it would have been obvious to a PHOSITA to blend four such resins. A PHOSITA knew that blending a high HLMI resin with a low HLMI resin can provide a resin having desirable mechanical rheological properties. (Ex. 1002 ¶115.) A PHOSITA also knew that using blends of recycled and virgin resins can reduce cost. (*Id.* ¶¶54–55, 116; Ex. 1003 ¶0005.) It would have been obvious to use four such resins to obtain the desired mechanical and rheological properties at reduced cost. (Ex. 1002 ¶¶115–16.)

As shown below, Harris and Nakayama disclose every limitation of claim 2. (*Id.* ¶¶144–45.)

'276 Patent	Harris and Nakayama
2. The composition of claim 1, wherein each of said first virgin polyethylene resin, said second virgin polyethylene resin, said first post-	“In a preferred embodiment of the invention illustrated in FIG. 7, the LLDPE (30) is melt blended with both a unimodal H-HDPE (40) and a HMW-HDPE (60) to produce the trimodal MWD curve illustrated in FIG. 8. In comparison with the conventional HDPE resin, the low molecular weight tail in this embodiment of the melt blend is greatly reduced.” (Ex. 1003, ¶0026, Fig. 7)

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consumer polyethylene resin, and said second post-consumer polyethylene resin is a high density polyethylene.	“In an embodiment of the invention, the HDPE can be selected from the group consisting of a high molecular weight high density polyethylene resin (HMW-HDPE) having a melt flow index of about 0.01 to about 0.2, a homopolymer high density polyethylene resin. (H-HDPE) having a melt flow index of about 0.1 to about 1.5, and mixtures of these. The HMW-HDPE can have a density of about 0.941 to about 0.958 g/cm, preferably about 0.945 to about 0.955 g/cm. The H-HDPE can have a density of about 0.957 to about 0.970 g/cm, preferably about 0.959 to about 0.965 g/cm.” (Ex. 1003, ¶0008)

3. Claim 3.

Harris discloses that the first virgin polyethylene resin has a density of about 0.941 to about 0.958 g/cm³, preferably about 0.945 to about 0.955 g/cm³. (Ex. 1003 ¶0033.) This disclosure applies to the Example 2 first virgin polyethylene resin because it discloses the preferred density range for the HMW-HDPE. (*Id.*; *Id.* ¶0059.)

Additionally, the claimed density range would have been obvious. Harris’s disclosure of preferably about 0.945 to about 0.955 g/cm³ overlaps with the claimed 0.948–0.955 g/cm³ range. The prior art has recognized that density is a result-effective variable. Further, it would have been obvious to optimize the density to achieve the desired strength and stiffness of the final product.

As shown below, Harris and Nakayama disclose every limitation of claim 3.

(Ex. 1002 ¶¶146–47.)

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3. The composition of claim 1, wherein said first virgin polyethylene resin, has a density of from about 0.948 to 0.955 g/cm ³ .	“In an embodiment of the invention, the HDPE can be selected from the group consisting of a high molecular weight high density polyethylene resin (HMW-HDPE) having a melt flow index of about 0.01 to about 0.2, a homopolymer high density polyethylene resin. (H-HDPE) having a melt flow index of about 0.1 to about 1.5, and mixtures of these. The HMW-HDPE can have a density of about 0.941 to about 0.958 g/cm ³ , preferably about 0.945 to about 0.955 g/cm ³ .” (Ex. 1003, ¶0008)

4. Claims 4, 5, and 6.

Harris discloses that the second virgin polyethylene resin has a density of preferably about 0.959 to about 0.965 g/cm³. (Ex. 1003 ¶0033.) This disclosure applies to the second virgin polyethylene resin of Example 2 because it discloses the preferred density range for the H-HDPE. (*Id.*; *Id.* at ¶0058.)

Harris discloses that the first virgin polyethylene resin has a density of about 0.941 to about 0.958 g/cm³. (Ex. 1003 ¶0033.) A PHOSITA would have recognized that a portion of this resin could be a post-consumer recycled resin having substantially similar properties. (Ex. 1002 ¶¶137, 151.) Accordingly, a PHOSITA would have recognized that Harris teaches that the first post-consumer recycled resin has a density of about 0.941 to about 0.958 g/cm³. This density disclosure applies to the first virgin polyethylene resin of Example 2 because

Harris teaches the preferred density range for the HMW-HDPE. Harris teaches that the HMW-HDPE could be a mixture of virgin and post-consumer recycled resins having substantially similar properties. (Ex. 1003 ¶¶0033, 0059.)

Harris discloses that the second virgin polyethylene resin has a density of about 0.957 to about 0.970 g/cm³. (Ex. 1003 ¶0033.) A PHOSITA would have recognized that a portion of this resin could be a post-consumer recycled resin having substantially similar properties. (Ex. 1002 ¶¶140, 153.) Accordingly, a PHOSITA would have recognized that Harris taught that the first post-consumer recycled resin has a density of about 0.957 to about 0.970 g/cm³. (*Id.*) This disclosure also applies to the second virgin polyethylene resin of Example 2 because it discloses the preferred density range for the H-HDPE, and a PHOSITA would have recognized that H-HDPE resin could be a mixture of virgin and post-consumer recycled resins having substantially similar properties. (*Id.*; Ex. 1003 ¶¶0033, 0058.)

Additionally, the claimed density range would have been obvious. Harris's disclosure of preferably about 0.945 to about 0.955 g/cm³ overlaps with the claimed 0.948–0.955 g/cm³ range. Density is a result-effective variable, such that there would be a known and established incentive to modify the variable to determine the optimum or workable range. It would have been obvious to

optimize the density to achieve the desired strength and stiffness of the final product. (Ex. 1002 ¶¶67.)

Harris and Nakayama disclose every limitation of claims 4, 5, and 6. (Ex. 1002 ¶¶148–53.)

'276 Patent	Harris and Nakayama
4. The composition of claim 1, wherein said second virgin polyethylene resin, has a density of from about 0.950 to 0.960 g/cm ³ .	“The H-HDPE can have a density of about 0.957 to about 0.970 g/cm, preferably about 0.959 to about 0.965 g/cm.” (Ex. 1003, ¶0008)
5. The composition of claim 1, wherein said first post-consumer polyethylene resin has a density of from about 0.955 to 0.970 g/cm ³ .	“The HMW-HDPE can have a density of about 0.941 to about 0.958 g/cm, preferably about 0.945 to about 0.955 g/cm.” (<i>Id.</i> ¶0008)
6. The composition of claim 1, wherein said second post-consumer polyethylene resin has a density of from about 0.952 to 0.958 g/cm ³ .	“The HMW-HDPE can have a density of about 0.941 to about 0.958 g/cm, preferably about 0.945 to about 0.955 g/cm.” (<i>Id.</i> ¶0008)

5. Claims 9, 10, and 11.

Regarding claim 9, a PHOSITA would recognize that Harris teaches that the weight ratio of first and second virgin resins to first and second post-consumer

recycled resins is about 0.8–1.2–1.2–0.8. As discussed above, Harris teaches using both recycled and virgin resins instead of pure virgin resins. A PHOSITA would have recognized that Harris discloses using recycled resins such that the weight ratio of virgin resins to recycled resins is within the claimed range. (Ex. 1002 ¶158.) For example, in Harris’s Example 2, providing the H-HDPE and HMW-HDPE each in equal parts of virgin and recycled resin provides the claimed weight ratio. (Ex. 1003, ¶¶0057–0060.) Additionally, claim 9 would have been obvious because the weight ratio of virgin to recycled resin is a result-effective variable and thus a PHOSITA would have found it obvious to optimize the ratio. (Ex. 1002 ¶¶88–89.)

Regarding claim 10, Harris teaches that weight ratio of first virgin resin to second virgin resin is about 1:1. (Ex. 1003, ¶¶0057–0060.)

Regarding claim 11, Harris teaches that the weight ratio of the first post-consumer recycled resin to the second post-consumer recycled resin is about 0.8–1.2–1.2–0.8. (*Id.*) A PHOSITA would recognize that Harris teaches substituting recycled resins for virgin resins. (Ex. 1002 ¶¶116, 136–37.) A PHOSITA would have recognized substituting equal parts of the two recycled resins for the two virgin resins. (*See id.*)

Additionally, the claimed ratio ranges of the first virgin to second virgin resins and first PCR to second PCR resins would have been obvious. The weight

ratios of resins having different melt flow properties are result-effective variables, as demonstrated by Harris’s teaching that a PHOSITA could vary the proportions of the melt blend components in until the desired melt flow is achieved. (Ex. 1003, ¶¶0043.) It would have been obvious to a PHOSITA to optimize the resin ratio to achieve the desired mechanical properties at the required processability. (Ex. 1002 ¶¶88–89.)

Harris and Nakayama disclose every limitation of claims 9–11. (*Id.* ¶¶157–63.)

'276 Patent	Harris and Nakayama
<p>9. The composition of claim 1, wherein a weight ratio of the total of said first and second virgin polyethylene resin: the total of said first and second post-consumer polyethylene resin in the composition is from about 0.8-1.2:1.2-0.8.</p>	<p>“The percentages by weight of the polyethylene components used to produce a melt-blended polyethylene composition Suitable for a producing a pipe having a diameter of about 12 to about 18 inches are listed below. The physical properties of the resulting melt-blended polyethylene com position are illustrated in Table 1. 40% H-HDPE 40% HMW-HDPE 20% LLDPE” (Ex. 1003, ¶¶0057-0060)</p> <p>“Similarly, it is generally understood that the processability of corrugated pipe is improved by an increased stiffness of the melt blend, in comparison to the stiffness of the melt blend used to produce profile pipe. Accordingly, one of ordinary skill in the art could produce pipe according to the invention by varying the proportions of the melt blend components in the melt blend until the desired melt flow index and density of the composition was achieved, without undue experimentation.” (Ex. 1003, ¶¶0043)</p>

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10. The composition of claim 1, wherein a weight ratio of the first virgin polyethylene resin to the second virgin polyethylene resin is from about 0.8-1.2.	<i>See claim 9.</i>
11. The composition of claim 1, wherein a weight ratio of the first post-consumer polyethylene resin to the second post-consumer polyethylene resin is from about 0.8-1.2:1.2-0.8.	<i>See claim 9.</i>

6. Claim 12.

Claim 12 recites the limitations of claims 2–6. Petitioner incorporates by reference the discussion of claims 2–6. Harris and Nakayama disclose every limitation of claim 12.

'276 Patent	Harris and Nakayama
[12.0] The composition of claim 1,	<i>See claim 1.</i>
[12.1] wherein each of said first virgin polyethylene resin, said second virgin	<i>See claim 2.</i>

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<p>polyethylene resin, said first post- consumer polyethylene resin, and said second post-consumer polyethylene resin is a high density polyethylene;</p>	
<p>[12.2] wherein said first virgin polyethylene resin, has a density of from about 0.948 to 0.955 g/cm³,</p>	<p><i>See claim 3.</i></p>
<p>[12.3] said second virgin polyethylene resin, has a density of from about 0.950 to 0.960 g/cm³,</p>	<p><i>See claim 4.</i></p>
<p>[12.4] said first post-consumer polyethylene resin has a density of from about 0.955 to 0.970 g/cm³,</p>	<p><i>See claim 5.</i></p>
<p>[12.5] said second post-consumer polyethylene resin has a density of from about 0.952 to 0.958 g/cm³;</p>	<p><i>See claim 6.</i></p>
<p>[12.6] wherein the particle size of said first and second virgin polyethylene resin is each independently</p>	<p><i>See [1.5].</i></p>

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comprising a particle size distribution of less than about 50 μm .	

7. Claims 13 and 14.

Claim 13 recites the claim 1 composition and further recites a polyethylene product comprising that composition. For the reasons set forth in section IX.B.1, which Petitioner incorporates by reference, the limitations of claim 1 are obvious. Harris discloses a polyethylene product formed of the claim 1 composition. (Ex. 1003 ¶¶0005.)

Harris and Nakayama disclose every limitation of claims 13 and 14. (Ex. 1002 ¶¶121–43; 164–65.)

'276 Patent	Harris and Nakayama
[13.0] A polyethylene product comprising a composition comprising:	<p><i>See</i> [1.0].</p> <p>“The invention provides a melt-blended polyethylene composition that, when used in the manufacture of profile and corrugated pipe, pipe fittings, and the like, results in products that meet or exceed AASHTO standards for density, MFI, flexural modulus, tensile strength and stress crack resistance.” (Ex. 1003, ¶¶0005)</p> <p>“The composition is also useful in the manufacture of other extruded, molded or formed plastic articles Such as, but not limited to, Smooth or corrugated conduit pipe for electrical, fiber-optic and telecommunication applications, wire and cable insulation materials, injection molded parts, extruded films and sheets...and the like, especially</p>

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	for applications in which good stress crack resistance is desired.” (<i>Id.</i> ¶0019)
[13.1] i) a first virgin polyethylene resin,	<i>See</i> [1.1].
[13.2] having a bimodal molecular weight distribution which is high molecular weight (HMVV),	<i>See</i> [1.2] & [1.3].
[13.3] having a high load melt index measured according ASTM D-1238 (HLMI) of from about 1 to 6 g/10 min;	<i>See</i> [1.4].
[13.4] and comprising a particle size distribution of less than about 50 µm	<i>See</i> [1.5].
[13.5] ii) a second virgin polyethylene resin,	<i>See</i> [1.6].
[13.6] an HLMI from about 20-70 g/10 min,	<i>See</i> [1.7].
[13.7] a melt flow index measured according ASTM D-1238 (MFI) of from about 0.20-0.60 g/10 min,	<i>See</i> [1.8].

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[13.8] and comprising a particle size distribution of less than about 50 μm ;	<i>See</i> [1.5].
[13.9] iii) a first post-consumer polyethylene resin, having a MFI of from about 0.10-0.70 g/10 min;	<i>See</i> [1.10]–[1.11].
[13.10] iv) a second post-consumer polyethylene resin,	<i>See</i> [1.12].
[13.11] which is HMW,	<i>See</i> [1.13].
[13.12] and having a HLMI of from about 4-8 g/10 min; and	<i>See</i> [1.14].
[13.13] v) a polyethylene antioxidant.	<i>See</i> [1.15].
14. The polyethylene product as defined in claim 13 which is an extruded product.	<p>“The invention also provides methods for producing the melt blended polyethylene compositions according to embodiments of the invention, and extruded, molded or formed products, especially pipes and/or pipe fittings, comprising the composition.” (Ex. 1003, ¶0010)</p> <p>“The composition is particularly useful for extruded, injection molded and blow molded profile and corrugated pipe and pipe fittings.” (Ex. 1003, ¶0019)</p>

8. Claim 15.

Claim 15 recites a process for preparing a polyethylene product comprising the claim 1 composition. For the reasons set forth in section IX.B.1, which Petitioner incorporates by reference, these limitations are obvious. Harris discloses the steps of providing the resins, blending the resins and antioxidant, and melting and shaping the blend. (Ex. 1003 ¶¶0010, 0050.)

Harris and Nakayama disclose every limitation of claim 15. (Ex. 1002 ¶¶166–67.)

'276 Patent	Harris and Nakayama
[15.0] A process for preparing an polyethylene product, said process comprising the steps of:	<i>See</i> [13.0].
[15.1] (a) providing: i) a first virgin polyethylene resin,	<i>See</i> [1.1].
[15.2] having a bimodal molecular weight distribution	<i>See</i> [1.2].
[15.3] which is high molecular weight (HMVV),	<i>See</i> [1.3].
[15.4] having a high load melt index measured according ASTM D-1238 (HLMI) of from	<i>See</i> [1.4].

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about 1 to 6 g/10 min;	
[15.5] and comprising a particle size distribution of less than about 50 μm ;	<i>See</i> [1.5].
[15.6] ii) a second virgin polyethylene resin,	<i>See</i> [1.6].
[15.7] an HLMI of from about 20-70 g/10 min,	<i>See</i> [1.7].
[15.8] a melt flow index measured according ASTM D-1238 (MFI) of from about 0.20-0.60 g/10 min,	<i>See</i> [1.8].
[15.9] and comprising a particle size distribution of less than about 50 μm ;	<i>See</i> [1.5].
[15.10] iii) a first post-consumer polyethylene resin,	<i>See</i> [1.10].
[15.11] having a MFI of from about 0.10-0.70 g/10 min;	<i>See</i> [1.11].
[15.12] iv) a second post-consumer polyethylene resin,	<i>See</i> [1.12].

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[15.13] which is HMW, and having a HLMI of from about 4-8 g/10 min; and	<i>See</i> [1.13]–[1.14].
[15.14] v) a polyethylene antioxidant;	<i>See</i> [1.15].
[15.15] (b) blending i) to v) from step (a); and	“The invention also provides methods for producing the melt blended polyethylene compositions according to embodiments of the invention, and extruded, molded or formed products, especially pipes and/or pipe fittings, comprising the composition.” (Ex. 1003, ¶0010)
[15.16] (c) melting and shaping the blend from step (b) to obtain said polyethylene product.	“Following melt blending of the components, the composition can be injection molded, blow molded, rolled, milled, sheet extruded, film extruded, pipe extruded, or formed or fabricated in any manner whatsoever to form the desired product by known methods.” (<i>Id.</i> ¶0049)

C. Ground 2: Claims 1–15 Are Obvious In View Of Thomas, Starita, And Nakayama.

1. Claims 1, 7, and 8.

(a) Thomas’s Disclosures.

Thomas discloses blending virgin and recycled polyethylene resins to achieve a composition having the desired properties for corrugated drainage pipe, and specifically discloses a four-resin composition including an antioxidant. (Ex. 1005 pp.1, 33, Table 8, Sample B3.) Regarding resin (i), the composition includes a first virgin polyethylene resin. (*Id.* (“VR1”); *id.* p.26, Table 6.) The first virgin

resin may have a bimodal molecular weight distribution. (*Id.* p.49.) The melt flow rate of the VR1 resin indicates that it is HMW. (*Id.* p.33.) Regarding resin (ii), Thomas discloses a second virgin polyethylene resin. (Ex. 1005 p.33, Table 8, Sample B3 (“LMDPE”).) Regarding resin (iii), Thomas discloses a first post-consumer polyethylene resin. (*Id.* (“PCR-MCR”).) The first post-consumer polyethylene resin has an MFI of 0.49 g/10 min. (*Id.* Appendix D-23, Table D-10.) Regarding Resin (iv), Thomas discloses a second post-consumer polyethylene resin. (Ex. 1005 p.33, Table 8, Sample B3 (“PCR-NAT”).) Thomas also discloses including an antioxidant. (Ex. 1005 p.50 (“Irganox”).)

(b) Starita’s Disclosures.

Like Thomas, Starita discloses compositions for HDPE corrugated pipe. (Ex. 1006 ¶¶0002.) Starita discloses a method of blending and varying virgin and recycled HDPE components of different density and melt indices to achieve the desired mechanical and processability properties at lower cost. (*Id.* ¶¶0006–0007.) Starita discloses that selecting and blending the HMW HDPE, LMW HDPE homopolymer, and LMWHDPE copolymer provides the corrugated HDPE pipe manufacturer with polyethylene compositions and the means to independently design physical properties and enhance processability while maintaining ESCR. (*Id.* ¶¶0008–0014.)

Starita discloses utilizing an HMW HDPE component that has a bimodal molecular weight distribution. (Ex. 1006 ¶0035.) This resin has an HLMI of about 0.01 to 1 g/10 min. (*Id.*) Such bimodal HMW HDPE resin increases the ESCR compared to unimodal HMW HDPE. (*Id.*)

Starita discloses utilizing a LMW HDPE component to enhance processability. (*Id.* ¶0036.) The LMW HDPE component has an MFI of about 1 to about 100 g/10 min. (*Id.*)

Starita discloses a method for selecting and blending polyethylene compositions to independently select physical properties and enhance processability. (*Id.* ¶0007.)

(c) Nakayama's Disclosures.

Petitioner incorporates by reference Nakayama's disclosures discussed in Ground 1.

(d) It would have been obvious to modify Thomas in light of Starita and Nakayama.

A PHOSITA would have found it obvious to modify Thomas's Example B3 in light of Starita's disclosure to achieve a resin with higher ESCR at lower cost. A PHOSITA would have found it obvious to modify Thomas's first virgin HMW polyethylene resin to use Starita's bimodal HMW HDPE resin having an HLMI of about 0.01 to 1 g/10 min because the resin increases ESCR compared to unimodal HMW HDPE. (Ex. 1002 ¶170; Ex. 1006 ¶0035.)

To the extent Thomas's second virgin polyethylene resin does not possess the claimed HLMI or MFI, it would have been obvious to modify Thomas to use Starita's LMW HDPE resin or to use a polymer with a higher MFI compared to the HMW HDPE first virgin resin. (Ex. 1002 ¶171; Ex. 1006 ¶0036.) This higher HLMI and MFI allows for the second resin to easily mix with the high viscosity first resin. (Ex. 1002 ¶171; Ex. 1006 ¶0037.)

To the extent Thomas does not disclose that the second post-consumer recycled resin is HMW having HLMI of from about 4–8 g/10 min, it would have been obvious to modify Thomas in light of Starita. (Ex. 1002 ¶172.) Starita discloses that the polyethylene components should have different values of melt index to enhance the processability. (Ex. 1006 ¶0007.) Given that Thomas's first post-consumer resin has low MFI, a PHOSITA would have been motivated based on Starita's disclosure to use a high MFI resin for the second post-consumer resin to enhance processability. (Ex. 1006 ¶0007; Ex. 1002 ¶172.)

The claimed ranges for HLMI and MFI would have been obvious because the disclosures in Thomas and/or Starita overlap with the claimed ranges. The prior art has recognized HLMI and MFI as result-effective variables. Accordingly, the claimed ranges would have been obvious. *E.I. DuPont*, 904 F.3d at 1006.

A PHOSITA would have found it obvious to modify the Thomas composition to incorporate the first and second virgin resins in the form of

microparticles having a median diameter between 3 and 25 μm as taught by Nakayama. As Nakayama explains, “[i]n recent years, polymer microparticles are actively developed and widely used for various industrial applications.” A PHOSITA would have been motivated to incorporate the microparticles of Nakayama because microparticles have excellent flowability and bulk density. (*Id.* at 3:15–20.) A PHOSITA also understood that resins with high viscosity differences are difficult to mix. (Ex. 1002 ¶¶174.) When resins are not homogeneously mixed, it can lead to undesirable properties or flaws in the final product. More homogeneity in the mixing leads to a more homogeneous final product, which is desirable in the polyethylene industry. (*Id.*) A PHOSITA would have understood that it would have been desirable to minimize the particle size of the resins to increase the ease of mixing and homogeneity, particularly in light of the high HLMI differences between the resins disclosed in Thomas as modified by Starita. (*Id.*)

Thomas, Starita, and Nakayama disclose the limitations of claims 1, 7, and 8. (Ex. 1002 ¶¶176–99.)

'276 Patent	Thomas, Starita, and Nakayama
[1.0]	“This report provides potential specifications for corrugated drainage pipe manufactured with recycled high-density polyethylene (HDPE). The report details the research performed and includes proposed draft specifications for recycled HDPE, formulations of virgin

'276 Patent	Thomas, Starita, and Nakayama
	<p>and recycled HDPE, and drainage pipe containing recycled HDPE.” (Ex. 1005, Forward)</p> <p>“The method of selecting and blending the HMW HDPE copolymer, LMW HDPE homopolymer and LMW HDPE copolymer provides the corrugated HDPE pipe manufacturer with enhanced HDPE compositions and the means to independently design physical properties and enhance processability while exceeding AASHTO's standard for ESCR.” (Ex. 1006 Abstract.)</p>
[1.1]	<p>“Virgin Resin 1 VR1 PPI-certified AASHTO HDPE pipe resin.” (Ex. 1005, p.26 Table 6; p.33 Table 8 (Formulation B3).)</p> <p>“A further embodiment utilizes HMW HDPE major component 20 (FIG. 8) having a bimodal molecular weight distribution (MWD).” (Ex. 1006 ¶0035.)</p>
[1.2]	<p>“data has become available about the stress-crack resistance of bimodal HDPE resins.</p> <p>...</p> <p>It’s possible that the addition of just around 10% of these resins would raise the NCLS times of the recycled above the required value of 24 h.” (Ex. 1005, pp.49–50.)</p> <p>“there are new bi-modal resins with densities that meet M294 requirements and that have thousands of hours of stress-crack resistance. It would be valuable to see the effects of adding these resins to recycled content.” (<i>Id.</i> pp.31–32.)</p> <p>“A further embodiment utilizes HMW HDPE major component 20 (FIG. 8) having a bimodal molecular weight distribution (MWD).” (Ex. 1006 ¶0035.)</p>

'276 Patent	Thomas, Starita, and Nakayama
[1.3]	<p>“The molecular weight also varies from injection molding grade (low molecular weight [LMW], high MI) to thermoforming or blown film (high MW [HMW], low MI).” (Ex. 1005 p.15; <i>id.</i> p.33.)</p> <p>“A further embodiment utilizes HMW HDPE major component 20 (FIG. 8) having a bimodal molecular weight distribution (MWD).” (Ex. 1006 ¶0035.)</p>
[1.4]	<p>“The HMW bimodal film grade high-density polyethylene, typically, has a density of 0.949 to 0.955 grams per cubic inch and MI values of 0.01 to 1.0 grams per 10 minutes.” (Ex. 1006 ¶0035.)</p>
[1.5]	<p>The median diameter (d_{50}) of the ethylene-based polymer microparticles of the present invention is $3 \mu\text{m} \leq d_{50} \leq 25 \mu\text{m}$, and preferably $3 \mu\text{m} \leq d_{50} \leq 10 \mu\text{m}$. (Ex. 1004 at 7:42–45.)</p>
[1.6]	<p>“Virgin LMDPE LMDPE Commercial linear medium-density polyethylene resin from a supplier that makes AASHTO pipe resin.” (Ex. 1005, p.26, Table 6; p.33 Table 8 (Formulation B3).)</p> <p>“A mixture of low molecular weight HDPE homopolymer and copolymer components is utilized to enhance the processability and the physical properties of the resulting polyethylene composition.” (Ex. 1006 ¶0036.)</p>
[1.7]	<p>“both having MI from about 1 to about 100 grams per 10 minutes.” (Ex. 1006 ¶0036.)</p>
[1.8]	<p>Final MFI value of Sample B3 is listed as “0.27 g/10 min.” (Ex. 1005, p.33, Table 9.)</p> <p>“both having MI from about 1 to about 100 grams per 10 minutes.” (Ex. 1006 ¶0036.)</p>

'276 Patent	Thomas, Starita, and Nakayama
[1.9]	<i>See</i> [1.5].
[1.10]	<p>“Mixed-Color PCR 1 MCR1 Mixed-color post-consumer reprocessed HDPE pellets composed of colored and natural bottles.” (Ex. 1005 p.26, Table 6; p.33 Table 8 (Formulation B3).)</p> <p>“It is the further objective of this invention is to provide the corrugated HDPE pipe and fittings manufacturers, the opportunity to vary the blend ratios of virgin, recycled, off specification, wide specification, reprocessed and regrind HMW and low molecular weight HDPE's to obtain the required combination of physical and process properties of pipe and fittings.” (Ex. 1006 ¶0012.)</p>
[1.11]	<p><i>See</i> Ex 1005, Appendix D-23, Table D-10 (finding an average MI of the Mixed color PCR resin measured by three different test plants to be 0.49 g/10 min).</p> <p>“both having MI from about 1 to about 100 grams per 10 minutes.” (Ex. 1006 ¶0036.)</p>
[1.12]	<p>“Natural PCR NAT Post-consumer reprocessed HDPE pellets made from milk, juice, and water bottles.” (Ex. 1005, p.26, Table 6; p.33 Table 8 (Formulation B3).)</p> <p>“It is the further objective of this invention is to provide the corrugated HDPE pipe and fittings manufacturers, the opportunity to vary the blend ratios of virgin, recycled, off specification, wide specification, reprocessed and regrind HMW and low molecular weight HDPE's to obtain the required combination of physical and process properties of pipe and fittings.” (Ex. 1006 ¶0012.)</p>
[1.13]	<i>See</i> Ex. 1005 Appendix D-65 (finding PCR-NAT to have average MI of 0.70 g/10 min).

'276 Patent	Thomas, Starita, and Nakayama
	<p>“The molecular weight also varies from injection molding grade (low molecular weight [LMW], high MI) to thermoforming or blown film (high MW [HMW], low MI).” (<i>Id.</i> p.15.)</p> <p>“A further embodiment utilizes HMW HDPE major component 20 (FIG. 8) having a bimodal molecular weight distribution (MWD).” (Ex. 1006 ¶0035.)</p>
[1.14]	<p>“The HMW bimodal film grade high-density polyethylene, typically, has a density of 0.949 to 0.955 grams per cubic inch and MI values of 0.01 to 1.0 grams per 10 minutes.” (Ex. 1006 ¶0035.)</p>
[1.15]	<p>“2. Perform post-production tests on pipe manufactured with blends of virgin and recycled HDPE to assure its long-term stress-crack resistance and antioxidant effectiveness are equivalent to that of pipe made from virgin HDPE, as currently specified in AASHTO M294 or M252;” (Ex. 1005 p.3)</p> <p>“A common additive package that meets this requirement is 1000 ppm Irganox 1010 plus 500 ppm Irgaphos 168, or an equivalent.” (Ex. 1005, Appendix F-4)</p> <p>“It is known that corrugated polyethylene pipe composition may include additives such antioxidants....” (Ex. 1006 ¶0028.)</p>
[7.]	<i>See</i> [1.5].
[8.]	<i>See</i> [1.5].

2. Claim 2.

Thomas discloses that the first virgin resin (VR1), the first post-consumer resin (PCR-MCR), and the second post-consumer resin (PCR-NAT) are HDPE. (Ex. 1005 p.26, Table 7.) Additionally, all of the resins described in Starita are HDPE. (Ex. 1006 ¶0005.) A PHOSITA would have been motivated to use a HDPE resin for second virgin resin, as disclosed in Starita, because higher density polyethylene typically results in higher strength and stiffness. (Ex. 1002 ¶67.) A PHOSITA would additionally been motivated to use HDPE to comply with the AASHTO standards for density. (Ex. 1006 ¶0005.)

Thomas, Starita, and Nakayama disclose the limitations of claim 2. (Ex. 1002 ¶¶200–01.)

'276 Patent	Thomas, Starita, and Nakayama
[2.]	<p>See trial pipe formulation B3 in Table 8. (Ex. 1005, p.33, Table 8)</p> <p>“Virgin Resin 1 VR1 PPI-certified AASHTO HDPE pipe resin.” (<i>Id.</i> Table 1)</p> <p>“Mixed-Color PCR 1 MCR1 Mixed-color post-consumer reprocessed HDPE pellets composed of colored and natural bottles.” (<i>Id.</i> p.26, Table 6)</p> <p>“Natural PCR NAT Post-consumer reprocessed HDPE pellets made from milk, juice, and water bottles.” (<i>Id.</i> p.26, Table 6)</p> <p>“The object of this invention is to disclose blends of commodity HDPE components....” (Ex. 1006 ¶0005.)</p>

3. Claims 3–6.

Thomas discloses the first virgin resin has a density of 0.950 g/cm³, the first post-consumer resin has a density of 0.960 g/cm³, and the second post-consumer resin has a density of 0.960 g/cm³. Starita discloses that the densities of the HMW resins (first virgin and second post-consumer resins) should be 0.949 to 0.955 g/cm³. (Ex. 1006 ¶¶0035.) A PHOSITA would have been motivated to use a HDPE resin for second virgin resin, as disclosed in Starita, because higher density polyethylene typically results in higher strength and stiffness. (Ex. 1002 ¶¶67.) A PHOSITA would additionally been motivated to use HDPE to comply with the AASHTO density standards. (Ex. 1006 ¶¶0005.)

The claimed density ranges would have been obvious. Thomas’s and Starita’s disclosures overlap with the claimed ranges. Density is a result-effective variable. It would have been obvious to optimize the density to achieve the desired strength and stiffness.

Thomas, Starita, and Nakayama disclose the limitations of claims 3–6. (Ex. 1002 ¶¶202–09.)

'276 Patent	Thomas, Starita, and Nakayama
[3.]	VR1 has a density of 0.950 g/cm ³ . (Ex. 1005, p.26, Table 7) “The HMW bimodal film grade high-density polyethylene, typically, has a density of 0.949 to 0.955 grams per cubic inch....” (Ex. 1006 ¶¶0035.)

'276 Patent	Thomas, Starita, and Nakayama
[4.]	“The bulk of commercially available injection molding grade copolymers have a density of about 0.950 to about 0.957 grams per cubic centimeter and injection grade homopolymers a density of about 0.958 to about 0.968 grams per cubic centimeter” (Ex. 1006 ¶0036.)
[5.]	<p>PCR-MCR1 has a density of 0.960 g/cm³. (Ex. 1005, p.26, Table 7)</p> <p>“The HMW bimodal film grade high-density polyethylene, typically, has a density of 0.949 to 0.955 grams per cubic inch....” (Ex. 1006 ¶0035.)</p>
[6.]	<p>PCR-NAT has a density of 0.960 g/cm³. (Ex. 1005, p.26, Table 7)</p> <p>“The bulk of commercially available injection molding grade copolymers have a density of about 0.950 to about 0.957 grams per cubic centimeter and injection grade homopolymers a density of about 0.958 to about 0.968 grams per cubic centimeter” (Ex. 1006 ¶0036.)</p>

4. Claims 9–11.

A PHOSITA would recognize that the claimed ratio ranges would have been obvious. The weight ratio of virgin to recycled resin is a result-effective variable. Additionally, Thomas discloses that a “pipe made with 50% or greater content of recycled HDPE can provide adequate short- and long-term properties and a service life comparable to pipe manufactured with 100% virgin HDPE.” (Ex. 1005, Foreword.) Thus, it would have been obvious to a PHOSITA to optimize the ratio

of virgin to recycled resin to achieve the desired cost savings at tolerable reduction of mechanical properties. (Ex. 1002 ¶¶213, 215.)

Similarly, the claimed ratio ranges of the first virgin to second virgin resins and first PCR to second PCR resins would have been obvious. The weight ratios of resins of different melt flow properties are result-effective variables because higher percentage of low HLMI resins relates to better mechanical properties but lower processability. (Ex. 1002 ¶¶76–77; Ex. 1003 ¶0038.) It would have been obvious to a PHOSITA to optimize the resin ratio to achieve the desired mechanical properties at the required processability. (Ex. 1002 ¶¶76–77, 213, 215.)

Thomas, Starita, and Nakayama disclose every limitation of claims 9–11. (Ex. 1002 ¶¶212–17.)

'276 Patent	Thomas, Starita, and Nakayama
[9.]	<p>The weight ratio of VR1 and Virgin LMDPE to PCR-MCR and PCR-NAT in sample B3 was 1.2:0.8. (Ex. 1005, p.33, Table 8)</p> <p>“Density and MI of the polyethylene composition can be varied independently by adjusting the ratio of the relative amounts of LMW HDPE homopolymer and copolymer and the ratio of the relative amount of the mixture of the LMW HDPE homopolymer and copolymer to amount of the HMW HDPE.” (Ex. 1006 ¶¶0036, 0067.)</p>
[10.]	<p>The weight ratio of VR1 to Virgin LMDPE in sample B3 was 1:2. (Ex. 1005, p.33, Table 8)</p>

'276 Patent	Thomas, Starita, and Nakayama
	<p>In other samples, the ratio of VR1 to Virgin LMDPE was closer to even. The weight ratio of VR1 to Virgin LMDPE in sample B3 was 4:3.</p> <p>(Ex. 1006 ¶¶0036, 0067.)</p>
[11.]	<p>The weight ratio of PCR-MCR to PCR-NAT in sample B3 was 1.2:0.8. (Ex. 1005, p.33, Table 8)</p> <p>(Ex. 1006 ¶¶0036, 0067.)</p>

5. Claim 12.

Claim 12 recites the limitations of claims 2–6. Petitioner hereby incorporates by reference the discussion of claims 2–6 in Sections IX.D.2 and 3. For the reasons discussed therein and as shown in the chart below, Thomas, Starita, and Nakayama disclose every limitation of claim 12.

'276 Patent	Thomas, Starita, and Nakayama
[12.0]	See claim 1.
[12.1]	See claim 2.
[12.2]	See claim 3.
[12.3]	See claim 4.

'276 Patent	Thomas, Starita, and Nakayama
[12.4]	See claim 5.
[12.5]	See claim 6.
[12.6]	See claim 7.

6. Claims 13 and 14.

Claim 13 recites the claim 1 composition and a polyethylene product comprising the claim 1 composition. Petitioner incorporates by reference its discussion of claim 1. Thomas further discloses a polyethylene product formed of the claim 1 composition. (Ex. 1005 p.1 (“corrugated drainage pipe”).) Regarding claim 14, Thomas discloses that the product is an extruded product. (*Id.* at A-2 (“Melt Blending by Extrusion”).)

Thomas, Starita, and Nakayama disclose every limitation of claims 13 and 14. (Ex. 1002 ¶¶177, 215.)

'276 Patent	Thomas, Starita, and Nakayama
[13.0]	“This report provides potential specifications for corrugated drainage pipe manufactured with recycled high-density polyethylene (HDPE). The report details the research performed and includes proposed draft specifications for recycled HDPE, formulations of virgin and recycled HDPE, and drainage pipe containing recycled HDPE.” (Ex. 1005, Foreword)

'276 Patent	Thomas, Starita, and Nakayama
[13.1]	<i>See</i> [1.1].
[13.2]	<i>See</i> [1.2] & [1.3].
[13.3]	<i>See</i> [1.4].
[13.4]	<i>See</i> [1.5].
[13.5]	<i>See</i> [1.6].
[13.6]	<i>See</i> [1.7].
[13.7]	<i>See</i> [1.8].
[13.8]	<i>See</i> [1.9].
[13.9]	<i>See</i> [1.10]–[1.11].
[13.10]	<i>See</i> [1.12].
[13.11]	<i>See</i> [1.13].

'276 Patent	Thomas, Starita, and Nakayama
[13.12]	<i>See</i> [1.14].
[13.13]	<i>See</i> [1.15].
[14.]	“All blending and extruding was performed on a laboratory line consisting of a Welding Engineers Model HT8-222-2251 Twin Screw Extruder....All samples for extrusion were dry blended then gravity fed. The batch size was typically 2.2 lb (1 kg)...Samples of recycled regrind chips were melt blended twice and recycled reprocessed pellets were melt blended once. All the experimental blends were melt blended three times to ensure optimum blending. Virgin resins were also blended in the same manner to duplicate the heat history of the blends.” (Ex. 1005, Appendix A-2)

7. Claim 15.

Claim 15 recites a process for preparing a polyethylene product comprising the claim 1 composition. Petitioner incorporates by reference the discussion of claim 1. Thomas further discloses providing the resins, blending the resins and antioxidant, and melting and shaping the blend. (Ex. 1005 at A-2.)

Thomas, Starita, and Nakayama disclose every limitation of claim 15. (Ex. 1002 ¶¶176–77.)

'276 Patent	Thomas, Starita, and Nakayama
[15.0]	<i>See</i> [13.1].

'276 Patent	Thomas, Starita, and Nakayama
[15.1]	<i>See</i> [1.1].
[15.2]	<i>See</i> [1.2].
[15.3]	<i>See</i> [1.3].
[15.4]	<i>See</i> [1.4].
[15.5]	<i>See</i> [1.5].
[15.6]	<i>See</i> [1.6].
[15.7]	<i>See</i> [1.7].
[15.8]	<i>See</i> [1.8].
[15.9]	<i>See</i> [1.5].
[15.10]	<i>See</i> [1.10].
[15.11]	<i>See</i> [1.11].

'276 Patent	Thomas, Starita, and Nakayama
[15.12]	<i>See</i> [1.12].
[15.13]	<i>See</i> [1.13] & [1.14].
[15.14]	<i>See</i> [1.15].
[15.15]	<p>“All blending and extruding was performed on a laboratory line consisting of a Welding Engineers Model HT8-222-2251 Twin Screw Extruder....All samples for extrusion were dry blended then gravity fed. The batch size was typically 2.2 lb (1 kg)...Samples of recycled regrind chips were melt blended twice and recycled reprocessed pellets were melt blended once. All the experimental blends were melt blended three times to ensure optimum blending. Virgin resins were also blended in the same manner to duplicate the heat history of the blends.” (Ex. 1005, Appendix A-2)</p>
[15.16]	<p>“All blending and extruding was performed on a laboratory line consisting of a Welding Engineers Model HT8-222-2251 Twin Screw Extruder....All samples for extrusion were dry blended then gravity fed. The batch size was typically 2.2 lb (1 kg)...Samples of recycled regrind chips were melt blended twice and recycled reprocessed pellets were melt blended once. All the experimental blends were melt blended three times to ensure optimum blending. Virgin resins were also blended in the same manner to duplicate the heat history of the blends.” (Ex. 1005, Appendix A-2)</p>

X. THERE IS NO EVIDENCE OF SECONDARY CONSIDERATIONS.

Petitioner is not aware of any secondary considerations not already addressed. Secondary considerations must be commensurate with the showing of obviousness—a weak showing of secondary considerations cannot overcome a strong obviousness case. *Wyers v. Master Lock Co.*, 616 F.3d 1231, 1246 (Fed. Cir. 2010). The patentee must establish a nexus between the secondary considerations and the claimed invention. *Ormco Corp. v. Align Tech., Inc.*, 463 F.3d 1299, 1311–12 (Fed. Cir. 2006). No nexus exists unless the secondary consideration results from an element that is both claimed and novel. *In re Kao*, 639 F.3d 1057, 1068, 1072 (Fed. Cir. 2011).

Petitioner reserves the right to respond to any secondary considerations the Patent Owner raises.

XI. CONCLUSION.

Petitioner requests that the Board grant this Petition and cancel claims 1–15 of the '276 Patent.

Date: July 21, 2021

Respectfully submitted,

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CERTIFICATE OF WORD COUNT

I hereby certify that the foregoing Petition for *Inter Partes* Review of U.S. Patent No. 10,570,276 includes the following number of words (as calculated by Microsoft Word), excluding those in the table of contents, table of authorities, mandatory notices, certificate of service, certificate of word count, and appendix of exhibits: 13,713.

Date: July 21, 2021

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CERTIFICATE OF SERVICE

I hereby certify on July 21, 2021, that a true and correct copy of the Petition for *Inter Partes* Review of U.S. Patent No. 10,570,276 was served in its entirety via e-mail and UPS to the Patent Owner by serving the correspondence address of record for the '276 Patent:

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