

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

RECYCLED PLASTICS INDUSTRIES, LLC
Petitioner

v.

TANGENT TECHNOLOGIES, LLC,
Patent Owner

Inter Partes Review No.: To Be Assigned
U.S. Patent No. 10,981,350

DECLARATION OF DR. KARL ENGLUND

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List of Exhibits

Exhibit No.	Description
RPI1001	U.S. Patent No. 10,981,350 (marked as Exhibit 4 during deposition of Francisco Morales in district court litigation)
RPI1002	USPTO Assignments on the Web for U.S. Patent No. 10,981,350
RPI1003	U.S. Provisional Patent Application No. 62/208,928 (marked as Exhibit 8 during deposition of Francisco Morales in district court litigation)
RPI1004	File History of U.S. Patent No. 10,981,350 (marked as Exhibit 7 during deposition of Francisco Morales in district court litigation)
RPI1005	Declaration of Dr. Karl Englund
RPI1006	<i>Curriculum Vitae</i> of Dr. Karl Englund
RPI1007	Deposition Transcript of Francisco Morales, <i>Tangent Techs., LLC v. Recycled Plastics Indus., LLC</i> , Case No. 1:23-cv-00261-WCG (E.D. Wis. Mar. 12, 2024)
RPI1008	Defendant Recycled Plastics Industries, LLC's Amended Notice of Rule 30(b)(6) Deposition to Plaintiff Tangent Technologies, LLC, <i>Tangent Techs., LLC v. Recycled Plastics Indus., LLC</i> , Case No. 1:23-cv-00261-WCG (E.D. Wis. Mar. 6, 2024) (marked as Exhibit 1 during deposition of Francisco Morales in district court litigation)
RPI1009	E-mail from J. Oehler to J. Zambrzycki (April 19, 2024) regarding <i>Tangent Techs., LLC v. Recycled Plastics Indus., LLC</i> , Case No. 1:23-cv-00261-WCG (E.D. Wis.)
RPI1010	"SMB Extrusion Melt Blender," StaMixCo (2007) (StaMixCo) (marked as Exhibit 10 during deposition of Francisco Morales in district court litigation)
RPI1011	Korean Patent No. 10-1338611 with Certified Translation (Nam)

Exhibit No.	Description
RPI1012	Zumbrunnen, D.A., “Chaotic Advection and Its Application to Extruding Micro- and Nanostructured Plastic Materials,” <i>Applied Plastics Engineering Handbook</i> (2011), 401-415 (Zumbrunnen)
RPI1013	U.S. Patent No. 9,527,341 (Rassi)
RPI1014	Defendant Recycled Plastics Industries, LLC’s Proposed Claim Constructions, <i>Tangent Techs., LLC v. Recycled Plastics Indus., LLC</i> , Case No. 1:23-cv-00261-WCG (E.D. Wis. Apr. 26, 2024)
RPI1015	Plaintiff Tangent Technologies, LLC’s Proposed Constructions for Disputed Claim Terms, <i>Tangent Techs., LLC v. Recycled Plastics Indus., LLC</i> , Case No. 1:23-cv-00261-WCG (E.D. Wis. Apr. 26, 2024)
RPI1016	Gardner, D. J. et al., “Wood-Plastic Composite Technology,” <i>Curr Forestry Rep</i> (June 4, 2015), 1:139-150 (Gardner)
RPI1017	Holden, B., “10 Things You Need To Know About Plastic Lumber,” <i>American Woodworker</i> (May 2005), 54-60 (American Woodworker)
RPI1018	Platt, B. et al., <i>The Healthy Building Network’s Guide to Plastic Lumber</i> (2005) (Platt)
RPI1019	U.S. Patent No. 9,359,762 (Nichols)
RPI1020	Internet Archive Affidavit of Nathaniel Frank-White (May 1, 2024) with Exhibits A-B
RPI1021	Meijer, H.E.H. et al., “On the performance of static mixers: a quantitative comparison,” <i>Progress in Polymer Science</i> (Jan. 1, 2012) 37(10):1333-49 (Meijer)
RPI1022	U.S. Patent No. 3,881,984 (Soda)
RPI1023	Saatdjian, E. et al., “On chaotic advection in a static mixer,” <i>Chemical Engineering Journal</i> (2012), 289-298 (Saatdjian)
RPI1024	Reserved

Exhibit No.	Description
RPI1025	U.S. Patent Application Publication No. 2012/0007277 (Nakamura)
RPI1026	U.S. Patent No. 9,533,444 (Philpot)
RPI1027	U.S. Patent Application Publication No. 2010/0032861 (Pietruczynik)
RPI1028	International Published Patent Application WO 98/52996 (Dorchester)
RPI1029	Kim, J. K. and Pal, Kaushik, <i>Recent Advances in the Processing of Wood-Plastic Composites</i> (2010) (Kim)
RPI1030	Wolcott, M. P. and Englund, K., “A technology review of wood-plastic composites,” <i>33rd International Particleboard Composite Materials Symposium</i> (January 1999), 103-111 (Wolcott)
RPI1031	Sidharta, A., “Wood Plastic Composites (WPCs) as an Alternative to Solid Lumber,” University of British Columbia (2011) (Sidharta)
RPI1032	United States Patent Application Publication No. 2015/0044434 (Kotiadis)
RPI1033	ASTM Standard Specification for Polyolefin-Based Plastic Lumber Decking Boards, D6662-13 (June 2013) (ASTM D6662-13)
RPI1034	Defendant Recycled Plastics Industries, LLC’s Notice of Deposition of Francisco Morales, <i>Tangent Techs., LLC v. Recycled Plastics Indus., LLC</i> , Case No. 1:23-cv-00261-WCG (E.D. Wis. Mar. 6, 2024) (marked as Exhibit 2 during deposition of Francisco Morales in district court litigation)

Exhibit No.	Description
RPI1035	Plaintiff Tangent Technologies, LLC's Initial Disclosures, <i>Tangent Techs., LLC v. Recycled Plastics Indus., LLC</i> , Case No. 1:23-cv-00261-WCG (E.D. Wis. Nov. 30, 2023) (marked as Exhibit 3 during deposition of Francisco Morales in district court litigation)
RPI1036	United States Design Patent No. D819,234 (marked as Exhibit 5 during deposition of Francisco Morales in district court litigation)
RPI1037	United States Design Patent No. D819,235 (marked as Exhibit 6 during deposition of Francisco Morales in district court litigation)
RPI1038	StaMixCo Principles of Operation Webpage Printout (Wayback Machine) (marked as Exhibit 9 during deposition of Francisco Morales in district court litigation)
RPI1039	Excerpts from File History of United States Design Patent No. D819,234 (marked as Exhibit 11 during deposition of Francisco Morales in district court litigation)
RPI1040	Excerpts from File History of United States Design Patent No. D819,235 (marked as Exhibit 12 during deposition of Francisco Morales in district court litigation)
RPI1041	Tangent Residential Materials Brochure (marked as Exhibit 13 during deposition of Francisco Morales in district court litigation)
RPI1042	Plaintiff Tangent Technologies, LLC's First Amended Complaint, <i>Tangent Techs., LLC v. Recycled Plastics Indus., LLC</i> , Case No. 1:23-cv-00261-WCG (E.D. Wis. May 18, 2023) (marked as Exhibit 14 during deposition of Francisco Morales in district court litigation)

Exhibit No.	Description
RPI1043	Photographs of Surfaces of Three Products (marked as Exhibit 15 during deposition of Francisco Morales in district court litigation)
RPI1044	Photographs of Cross-Sections of Three Products (marked as Exhibit 16 during deposition of Francisco Morales in district court litigation)

I, Dr. Karl Englund, do hereby declare as follows:

I. Scope of the Engagement

1. I have been retained by Moore & Van Allen PLLC on behalf of Petitioner Recycled Plastics Industries, LLC (“RPI” or “Petitioner”) to provide expert analysis and opinion in connection with RPI’s request for *Inter Partes* Review of U.S. Patent No. 10,381,350 (“the ’350 patent”) (RPI1001).

2. All of the opinions I express in this declaration are based on my experience and knowledge, and the information I have reviewed as of the date of this declaration. In connection with my analysis, I have reviewed the exhibits listed in the above list of exhibits as well as each of the items referenced herein. I have also been informed of the relevant legal standards, including the standard for obviousness set forth in *KSR International Co. v. Teleflex, Inc.*, 550 U.S. 398 (2007).

3. I am being compensated for my time spent on the present matter at my standard consulting rate of \$300 per hour. My compensation is not in any way contingent on my performance, the result of this proceeding, or any of the issues involved therein. I am also being reimbursed for expenses incurred as a result of activities performed as an expert.

4. I have personal knowledge of the facts contained in this declaration, am of legal age, and am otherwise competent to testify.

II. Professional Background and Qualifications

5. I earned my Bachelor of Science in Forestry from West Virginia University in Morgantown, West Virginia in 1988, my Master of Science in Wood Science from West Virginia University in 1991, and my Ph.D. in Civil Engineering from Washington State University in Pullman, Washington in 2001.

6. I have extensive experience in thermoplastic processing, as well as the utilization of waste materials as feedstocks for composites, bioenergy, and cross laminated timbers spanning a career of over thirty years in the field. My relevant expertise includes applied research, material characterization, product development, commercialization, and problem solving with regard to markets, processing options, contamination, policies, procedures, and education.

7. I have extensive consulting experience in all aspects of composite and thermoplastic materials processing and recycling, in the concrete, cross laminated timber, carbon fiber, pavement, fiberglass, polymer, biochar, aerospace, biofuel, forestry, and timber industries. As part of my consulting experience, I have developed enhanced concrete made with recycled waste products, wood modified styrenics, recycled thermoplastic and thermoset based carbon fiber reinforced composites, recycled fiberglass composites, scrap FRP composites, biochar pellets, forest residue-based pyrolysis biorefinery, panelized wood assemblies, wood-plastic composites, eco-friendly epoxy resins, modified wood fillers, and extrusion of

foamed polyvinyl chloride/wood flour composites. My consulting experience has involved data analysis, intellectual property review, expert opinions, business and market development activities, business technology, manufacturing evaluations, etc.

8. I have served on the faculty of Washington State University for fifteen years, with roles as an Assistant Research Professor and Extension Specialist, Research Associate Professor, and Research Professor. As part of my work at Washington State University, I have developed various wood-based composites, including wood/thermoplastic composites, as well as composites using waste and recycled materials. I also hold adjunct faculty positions in Washington State University's Department of Mechanical and Materials Engineering and Material Science and Engineering Program, as well as the University of Idaho's College of Natural Resources.

9. I have served on many professional committees and supported professional organizations. For example, I am currently the Co-Chair of the Advisory Board for the Recycling Development Center in the Washington State Department of Ecology and Chair of the Washington State University Intellectual Property Committee. In the past, I have served on the Advisory Board of the King County Solid Waste Carpet Recovery Program and the Composites Advisory Committee for Peninsula College, as well as the Education Committee for the

Washington State Recycling Association, and served on search committees for faculty appointments. I have also been involved in Conference Session Planning and served as a Conference Session Moderator for the American Chemical Society, Building Materials Reuse Association, Forest Products Society, and the WSU-International Wood Composite Symposium. I have served as Reviewer for the National Science Foundation (NSF), Department of Energy (DOE), U.S. Department of Agriculture (USDA), Ontario Research Fund, Swiss National Science Foundation, Natural Sciences and Engineering Research Council of Canada (NSCERC), WSU Seed Grant, Christian Doppler Research Association, and The World Academy of Sciences (TWAS).

10. I have served as a Technical Reviewer for numerous journals, including FOREST PRODUCTS JOURNAL, COMPOSITES PART A, JOURNAL OF APPLIED POLYMER SCIENCE, JOURNAL OF THERMOPLASTIC COMPOSITE MATERIALS, WOOD AND FIBER SCIENCE, JOURNAL OF ZHEJIANG UNIVERSITY – SCIENCE B, MATERIALS TODAY, JOURNAL OF POLYMERS AND THE ENVIRONMENT, BIORESOURCES, MADERAS, THERMOCHIMICA ACTA, TRIBIOLOGY TRANSACTIONS, JOURNAL OF WOOD CHEMISTRY AND TECHNOLOGY, EUROPEAN POLYMER JOURNAL, FUEL PROCESSING TECHNOLOGY, JOURNAL OF BIOBASED MATERIALS AND BIOENERGY, and JOURNAL OF COMPOSITE MATERIALS.

11. I have authored or co-authored several book chapters and publications in the field, including a chapter in WOOD POLYMER COMPOSITES (2008); “Performance of UV weathered HDPE composites containing hull fiber from DDGS and corn grain,” INDUSTRIAL CROPS & PRODUCTS, 107(15):409-414 (2017); “Effect of highly degraded high density polyethylene (HDPE) on processing and mechanical properties of wood flour-HDPE composites,” J. APPLIED POLY. SCI., 129(6):3404-3410 (2013); “Flexure and water sorption properties of wood thermoplastic composites (WPCs) made with polymer blends,” J. APPLIED POLY. SCI., 120(2):1034-1039 (2010); and “Effect of fiber length on processing and properties of extruded wood fiber/HDPE composites,” J. APPLIED POLY. SCI., 110(2):1085-1092 (2008). I am also a named inventor on six patent applications, including several directed to composite materials.

12. My qualifications and publications are set forth more fully in my curriculum vitae. *See* RPI1006.

III. Relevant Legal Standards

13. I have been asked to provide opinions related to the claims of the '350 patent in light of the prior art. I have been informed of the following legal standards that are relevant to my analysis.

A. Claim Interpretation

14. I understand that claim terms are to be given their ordinary and customary meaning as understood by a person of ordinary skill in the art in the context of the entire disclosure at the time of the invention, taking into consideration the language of the claims themselves, the specification, and the prosecution history of record (i.e., “intrinsic evidence”). I understand that one must be careful not to read a specific embodiment appearing in the written description into the claim if the claim language is broader than the embodiment. I further understand that any special definition for a claim term must be set forth with reasonable clarity, deliberateness, and precision. It is my further understanding that “extrinsic evidence” (which consists of evidence external to the patent and prosecution history, such as dictionaries, learned treatises, and expert and inventor testimony) may also be considered in claim construction, but cannot be used to contradict claim meaning found in the intrinsic evidence and is generally afforded less weight than the intrinsic evidence.

B. Obviousness

15. I am informed and understand that a patent claim is invalid under 35 U.S.C. § 103 if the differences between the invention and the prior art are such that the subject matter as a whole would have been obvious at the time of the invention to a person having ordinary skill in the art to which the subject matter pertains.

Obviousness, as I understand, is determined based on the scope and content of the prior art, the differences between the prior art and the claim, the level of ordinary skill in the art, and secondary indications of non-obviousness to the extent they exist.

16. I understand that whether there are any relevant differences between the prior art and the claimed invention is to be analyzed from the view of a person of ordinary skill in the art at the time of the invention. A person of ordinary skill in the art is a hypothetical person who is presumed to be aware of all of the relevant art at the time of the invention. The person of ordinary skill is not an automaton and may be able to fit together the teachings of multiple patents employing ordinary creativity and the common sense that familiar items may have obvious uses in another context or beyond their primary purposes.

17. The person of ordinary skill faced with a problem is able to apply his or her experience and ability to solve the problem and also look to any available prior art to help solve the problem.

18. I understand that an invention would have been obvious if a person of ordinary skill in the art, facing the wide range of needs created by developments in the field, would have seen an obvious benefit to the solutions tried by the applicant. When there is a design need or market pressure to solve a problem and there are a finite number of identified, predictable solutions, it would be obvious to a person of

ordinary skill to try the known options. If a technique has been used to improve one device, and a person of ordinary skill in the art would recognize that it would improve similar devices in the same way, using the technique would have been obvious.

19. I understand that I do not need to look for precise teachings in the prior art directed to the subject matter of the claimed invention. I understand that I may take into account the inferences and creative steps that a person of ordinary skill in the art would have employed in reviewing the prior art at the time of the invention. For example, if the claimed invention combined elements known in the prior art and the combination yielded results that were predictable to a person of ordinary skill in the art at the time of the invention, then this evidence would make it more likely that the claim was obvious. On the other hand, if the combination of known elements yielded unexpected or unpredictable results, or if the prior art teaches away from combining the known elements, then this evidence would make it more likely that the claim that successfully combined those elements was not obvious. I understand that hindsight must not be used when comparing the prior art to the invention for obviousness.

20. I understand that obviousness may be shown by demonstrating that it would have been obvious to modify what is taught in a single piece of prior art to

create the patented invention. Obviousness may also be shown by demonstrating that it would have been obvious to combine the teachings of more than one item of prior art. I understand that a claimed invention may be obvious if some teaching, suggestion, or motivation exists that would have led a person of ordinary skill in the art to combine the invalidating references. I also understand that this suggestion or motivation may come from sources such as explicit statements in the prior art, or from the knowledge of a person having ordinary skill in the art. Alternatively, any need or problem known in the field at the time and addressed by the patent may provide a reason for combining elements of the prior art. I also understand that when there is a design need or market pressure, and there are a finite number of predictable solutions, a person of ordinary skill may be motivated to apply both their skill and common sense in trying to combine the known options in order to solve the problem.

21. In determining whether a piece of prior art could have been combined with other prior art or with other information within the knowledge of a person having ordinary skill in the art, the following are examples of approaches and rationales that may be considered:

- Combining prior art elements according to known methods to yield predictable results;

- Simple substitution of one known element for another to obtain predictable results;
- Use of a known technique to improve similar devices, methods, or products in the same way;
- Applying a known technique to a known device, method, or product ready for improvement to yield predictable results;
- Applying a technique or approach that would have been “obvious to try” (choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success);
- Known work in one field of endeavor may prompt variations of it for use in either the same field or a different one based on design incentives or other market forces if the variations would have been predictable to a person having ordinary skill in the art; or
- Some teaching, suggestion, or motivation in the prior art that would have led one of ordinary skill to modify the prior art reference or to combine prior art reference teachings to arrive at the claimed invention.

IV. Qualifications of One of Ordinary Skill in the Art

22. Based on my review of the '350 patent, the '350 patent's prosecution history, the materials cited in both, and based on my experience, it is my opinion that the person of ordinary skill in the field of the '350 patent would have at least a

bachelor's degree in materials science, chemistry, or chemical engineering and at least five years of experience in the field of polymers or plastics processing. Individuals with different education and additional experience could still be of ordinary skill in the art if their additional experience compensates for a deficit in their education (as stated above) or vice versa.

23. I understand that this determination is made at the time of the alleged invention, which I understand to be no later than the August 24, 2015, filing date of U.S. Provisional Application No. 62/208,928 ("the '928 Provisional Application"), to which the '350 patent claims priority. I consider myself to have been a person of ordinary skill in the art as of at least that date, and am familiar with the level of knowledge and the abilities of a person having ordinary skill in the art at that time based on my experience as set forth above and in my curriculum vitae.

V. State of the Art

24. Polymers have been used to create various consumer and industrial products for generations. Over time, understanding of the material properties of those polymers and development of manufacturing techniques has enhanced the breadth of polymer materials used and expanded the list of products that may be created using those polymer materials.

25. Synthetic wood products have been available since the 1960s, which combined polymers with natural wood products, such as wood pulp or saw dust, to

be formed into the final product. As polymers and manufacturing methods continued to develop, fully synthetic polymer boards were created without any natural wood component. These fully synthetic materials, when implemented in various manufacturing methods, could be made to imitate or improve upon certain aspects of a natural wood board.

26. A variety of manufacturing techniques have been developed to deploy the various polymer-based combinations into a useful article.

A. History of Synthetic Wood Manufacture

27. The earliest plastic-composite wood was manufactured at the turn of the 20th century. RPI1016 at 139-40. Exclusively polymer boards mimicking natural wood have likewise been known for decades. *See, e.g.*, 1017 at 54-60; *see generally* RPI1018; RPI1001 at 1:15-30. Natural wood has limitations due to water intrusion that can deteriorate physical properties and aesthetics, resulting in a rise in popularity of synthetic boards. RPI1017 at 56; RPI1018 at v, 4; RPI1013 at 1:10-24. Even polymer boards with natural wood filler have become disfavored in some applications, as the organic material can be susceptible to color bleaching, decomposition, mold, and mildew. RPI1019 at 10:38-42. The rising popularity in polymer wood has also been driven by environmental concerns, as such polymeric wood can be manufactured from recycled materials rather than needing to continuously source wood. RPI1017 at 54; RPI1013 at 1:16-18; RPI1018 at 4.

Indeed, to potentially lower costs and create a more “green” product, manufacturers have often sought polymer boards that can be recycled and made from recycled material. *See* RPI1018 at 1-17.

28. Extrusion processes were commonly known and used to manufacture polymer synthetic wood products. RPI1012 at 401, 412-13; RPI1013 at Abstract, 1:66-3:47; RPI1019 at 8:52-63; RPI1016 at 139-40; RPI1001 at 1:38-40, 2:4-24. Many types of extruders have been used with or without static and dynamic mixers to create these products. RPI1013 at Abstract, 1:66-3:47; RPI1011 at Abstract, [0001]; RPI1012 at 401-06; RPI1001 at 1:38-40, 2:4-24; RPI1010 at 10. No matter the method of processing the polymer wood products, the mixing or blending strategies rely on chaotic advection to create the desired component. Inline, or static mixers, promote chaotic advection and have been in use for decades. RPI1021 at 1334; *see also* RPI1010 at 10. Zumbrunnen teaches us about the fluid mechanics description of chaotic advection, which generally involves a stretching and folding process and can be applied to many applications where two or more substances are combined. RPI1012 at 401-02.

B. Methods of Manufacture

29. It was known that many of these processes to synthesize plastic wood use an extruder with an attached die to shape the extruded substrate to suit specified design criteria. RPI1012 at 403, 412-13; RPI1022 at Abstract, 2:28-45, 3:56-4:9;

RPI1013 at 9:26-27; RPI1011 at Abstract, [0011], [0014]. The extruder is at the center of the synthesis process. *See* RPI1012 at 403-06; RPI1011 at Abstract, [0011], [0014]. The extruder is designed to melt the polymer(s) and can be used to mix any additives. RPI1011 at Abstract, [0011]; RPI1013 at 6:13-46. Inline or static mixers are often included in the extruder to help facilitate blending the polymers to create the desired pattern. RPI1011 at Abstract, [0011]; RPI1021 at Abstract, 1334-35. The die, or mold, serves only to form the shape of the plastic wood product after the mixture exits the extruder. RPI1012 at 403; RPI1022 at Abstract, 3:56-4:21; RPI1013 at 9:26-27; RPI1016 at 141 (“The die dictates the dimensions and profile (shape) of the extruded part.”); RPI1001, 1:38-40, 2:4-24.

30. Static mixers have been well known and in use among the engineering community for decades. RPI1021 at 1334; RPI1023 at 289. The static mixer was first patented in 1874. RPI1021 at 1334. Further, static mixers have been in use as early as the 1950s to blend polymers, highly viscous flows, and more. Static mixers have been incorporated into a host of industrial processes, including food processing, waste treatment operations, chemical reaction engineering, and so on. RPI1023 at 289; RPI1021 at 1334. Static, or inline mixers, continuously mix fluid streams without any moving mechanical parts. RPI1021 at 1334. The helical design of the static mixer promotes thorough mixing of flow streams through radial mixing.

RPI1023 at 290. Static mixers are functional for mixing other fluid types including gas-gas flows, gas-liquid flows, polymer-polymer flows, polymer-solid combinations, immiscible fluids, viscous fluids, and others. RPI1021 at 1334; RPI1012 at 401, 408.

31. It was also well recognized and documented that static mixers promote chaotic advection. RPI1021 at Abstract, 1334; RPI1023 at 289. Chaotic advection enables mixing for otherwise laminar flows, or flow characterized by uniform flow that runs parallel to the tube wall and shows no cross-sectional mixing. RPI1023 at 289-90, 297; RPI1012 at 401. Static mixers cause flows to split and reorient continuously as the flow moves through the blades of the mixer. RPI1023 at 289, 292, 297. This splitting and reorienting of the flow streams is similar to the stretching and folding which is characteristic of chaotic advection. RPI1021 at 1336-37, Fig. 2.

32. Plastic extrusions can be designed to resemble the appearance of natural wood. RPI1012 at 412-13; RPI1011 at [0001], Figs. 2-3. It was known that extrusion processes have continued to evolve into increasingly customizable tools. RPI1012 at 411-13. Zumbrunnen discloses a smart blender for outputting a diverse array of blended polymers which may also be decorative. RPI1012 at 401-03 (“Smart blenders have been developed for various purposes such as extruding cast film or

sheet, filaments, or fibers...”), at 403 (describing “desired extrusion form[s] such as a film, plate, or filament”). In Zumbrunnen, at least two polymer melts enter the extruder and pass through a region of chaotic advection that is determined by a selected number of time-periodic changes to the rotational speed of the stir rods, *N*. RPI1012 at 402-04. Polymer melt domains stretch and fold as a result of shear deformation. *Id.* at 402 (Figure 22.1). This stretching and folding promotes a progressive structure development. *Id.* at 402. The resulting plastic-composite is extruded through a die which shapes the extrudate. *Id.* at 403 (“In cast film or sheet and fiber applications, attached dies serve only to form an extrusion into a desired shape and dimension”).

33. It has been demonstrated that synthetic wood may exhibit grain patterns that are present both on the surface of the board but also throughout the core. RPI1013 at 1:66-2:20, Figures 1-3, 10-11; RPI1021 at 1339 (Figure 4), 1341; RPI1022 at Figures 15-18, 1:60-67, 3:55-4:9; RPI1011 at [0001], Figs. 2-3; RPI1012 at 407 (Figure 22.6), 410 (Figure 22.8), 413 (Figure 22.12); RPI1025 at Fig. 10; RPI1026 at Fig. 2C. The selection of colors would have been a mere design choice, depending on the color and look of the natural wood that was being simulated. In fact, colorant manufacturers sold “pigmented polymer resins” that were “intended specifically to impart wood appearance.” RPI1012 at 413. A person of ordinary skill

in the art would have therefore merely had to perform routine experimentation with the available colors to arrive at the specific look he or she was trying to achieve.

34. It has further been demonstrated that chaotic advection via static mixers promotes the formation of curved paths resulting from the stretching and folding of polymer melt domains occurring throughout the volume of the extrudate. RPI1023 at 293, 297 (Figures 8, 13); RPI1021 at 1337, 1339 (Figures 2, 4); RPI1012 at 413 (Figure 22.12); RPI1010 at 10 (Figure 20). In other words, it was known that cross-sections of the resulting extrudate will reveal many thin layers or striations which take curved paths. RPI1023 at 293, 297 (Figures 8, 13); RPI1021 at 1337, 1339 (Figures 2, 4); RPI1012 at 413 (Figure 22.12); RPI1010 at 10 (Figure 20).

35. Finishing steps or secondary processing are also key to simulating natural wood. It was known in the art to conduct “follow-up processes such as drying and cutting” polymer wood after the extrusion is molded. RPI1011 at [0027]; RPI1001 at 1:34-37, 1:62-65. A person of ordinary skill in the art would have been well-aware that this molded extrusion could be sanded, planed, cut, and otherwise shaped as a finishing step. RPI1011 at [0027]; RPI1001 at 1:34-37, 1:62-65; *see also* RPI1013 at 9:63-67, 10:28-30; RPI1017 at 59. Additional finishing techniques such as embossing were also known in the art at the time of the '350 patent. RPI1013 at 1:32-33, 3:20-22, 6:6-10; RPI1027 at [0004]; RPI1028 at 12:19-30; RPI1017 at 57;

RPI1001 at 1:34-37, 1:62-65. Polymer resins have also been stained to simulate the grain patterns of natural wood. RPI1013 at 1:66-2:20; RPI1012 at 413 (Figure 22.12); RPI1017 at 56-57; RPI1001 at 1:31-2:24.

C. Manufacturing Materials

36. A wide variety of polymers may be selected as starting agents including high density polyethylene (HDPE), low density polyethylene (LDPE), polyvinyl chloride (PVC), polystyrene (PS), and others. RPI1018 at 1; RPI1029 at 24-25; RPI1012 at 408; RPI1030 at 105. Generally, HDPE is an attractive polymer because of its moisture barrier and chemical resistance properties. RPI1029 at 24. Industry wide, HDPE has been one of the most commonly used polymers, and was known to be one of the most recyclable and recycled plastics. RPI1018 at 1, 4, 8, 10, 13, 16; RPI1031 at 14-15; RPI1030 at 105. Due to its recyclability, it was also considered the most environmentally preferable polymer for use in plastic lumber. RPI1018 at 2-3, 6, 8-11, 14, 19.

37. UV stabilizers were known to be added to prevent degradation of the plastic materials due to UV or light exposure and were a common additive. RPI1013 at 6:40-42; RPI1032 at [0015]; RPI1029 at vii; RPI1016 at 143; RPI1018 at 7, 19. Further, foaming agents were known to modify the density of the substrate through generation of bubbles which enter the polymer matrix and create void spaces therein, also creating a wood-like texture. RPI1031 at 17; RPI1013 at 5:66-6:12; RPI1029 at

vii; RPI1017 at 56. The end product is a lighter-weight polymer which creates a wood-like texture. RPI1013 at 6:1-12; RPI1022 at 5:20-35, 10:39-11:5, 14:24-32, Figures 20, 22(a), 23(a), 24(a); RPI1031 at 17.

VI. The '350 Patent

A. Priority Date of the '350 Patent

38. As I described above, I am informed and understand that the earliest date to which the '350 patent claims priority is August 24, 2015—the filing date of the '928 Provisional Application.

B. Disclosure of the '350 Patent

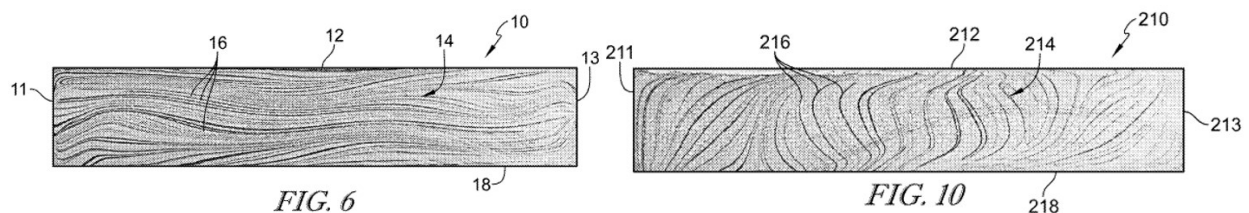
39. Based on my review, the '350 patent is directed to a “wood-grained polymer substrate [that] includes a plurality of layers of different colors. The substrate is formed into elongated boards and used in the production of various end products similar to natural wood.” RPI1001 at Abstract. More generally, the '350 patent “relates to polymer composites and more particularly to polymer composites that are used as a natural wood substitute or replacement.” RPI1001 at 1:13-15.

40. As the '350 patent recognizes, the “decking industry has seen numerous introductions of composite and alternative plastic lumber decking products over the past decade.” RPI1001 at 1:19-21.¹ The '350 patent alleges that these products lack

¹ Unless I specify otherwise, all emphasis in this declaration has been added.

“a wood-grain like appearance through a core of the board.” RPI1001 at 1:50-54. For example, the ’350 patent criticizes prior art products for either having a “homogenous core” with a “wood grain appearance” that is “only skin deep,” RPI1001 at 1:21-37, having patterns that “are not consistent throughout the board,” or as being otherwise deficient when subjected to “post processing steps, such as cutting,” which “can produce visible surfaces with undesirable characteristics.” RPI1001 at 2:21-25.

41. The ’350 patent claims to teach a substrate having a plurality of polymer layers that “alternate within the substrate to form a wood-grained appearance throughout the entire substrate.” RPI1001 at 2:30-38. Figures 6 and 10 each provides a “sectional view” taken through two different embodiments of “a polymer substrate in accordance with the present disclosure showing a wood grain pattern of the polymer substrate.” RPI1001 at 2:60-63, 3:4-7. “Each polymer substrate 10, 210 includes a multi-tone, simulated natural wood-grain effect that runs throughout the entire substrate (cross section) as shown in FIGS. 6 and 10,” reproduced below. RPI1001 at 3:52-54.



42. The “wood-grained polymer substrates 10, 210, as shown in FIGS. 6-11,” can have “varying patterns of simulated wood grain which extend through and along each substrate 10, 210.” RPI1001 at 3:25-30. “The simulated wood grains 16, 216 also extend to an outer surface, for example top surface 12, 212, of each substrate 10, 210 so that when removal of material occurs, such as through planing or cutting, the multi-tone wood grain effect remains both on the surface 12, 212 as well as with an exposed core 14, 214 of the substrates as suggested in FIGS. 9 and 11,” reproduced below. RPI1001 at 3:55-61.

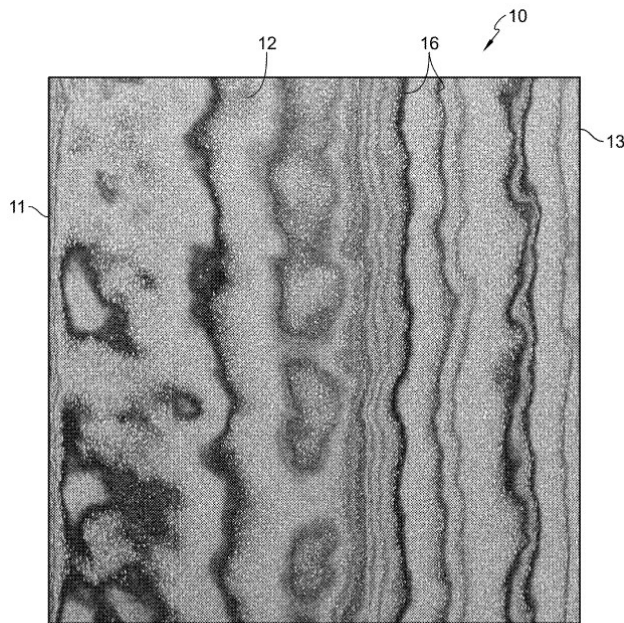


FIG. 9

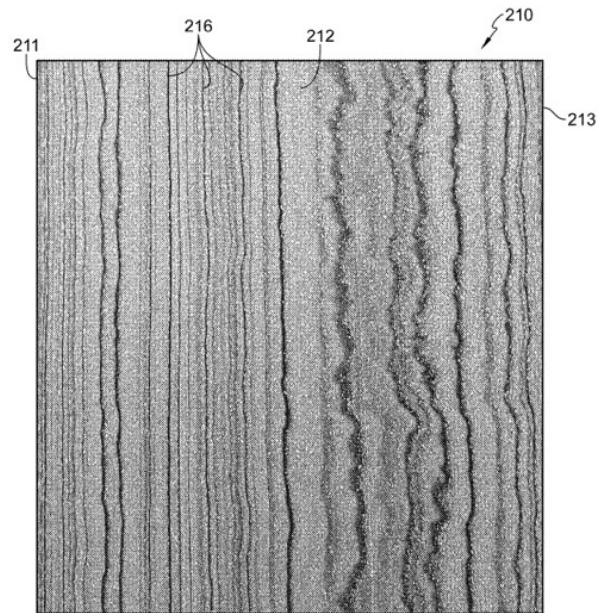


FIG. 11

43. The patent describes that “[s]ubstrates 10, 210 can be made from polymer based materials, such as recycled high density polyethylene (HDPE), having at least two different colorants added thereto to define the wood-grain

patterns.” RPI1001 at 3:30-33. The polymer substrates of the ’350 patent “can be free of natural wood or other organic fibers” and “can include additives, such as UV inhibitors, foaming agents, and color concentrates, to produce polymer substrates having desired colors and material properties, such as durability and strength.” RPI1001 at 3:33-39. Furthermore, the “wood-grained polymer substrates 10, 210 can be post-processed, such as by planing or embossing, and cut to form various sized boards used to make polymer-lumber end products.” RPI1001 at 3:40-43, 3:61-63.

44. Although the claims of the ’350 patent are directed to polymer substrates and boards, and not their method of manufacture, the ’350 patent nevertheless discloses at least one method by which the claimed products can be made: “using extrusion machine 100, shown in FIG. 1” (reproduced below), “from a first polymer 120 and a second polymer 124.” RPI1001 at 4:1-3.

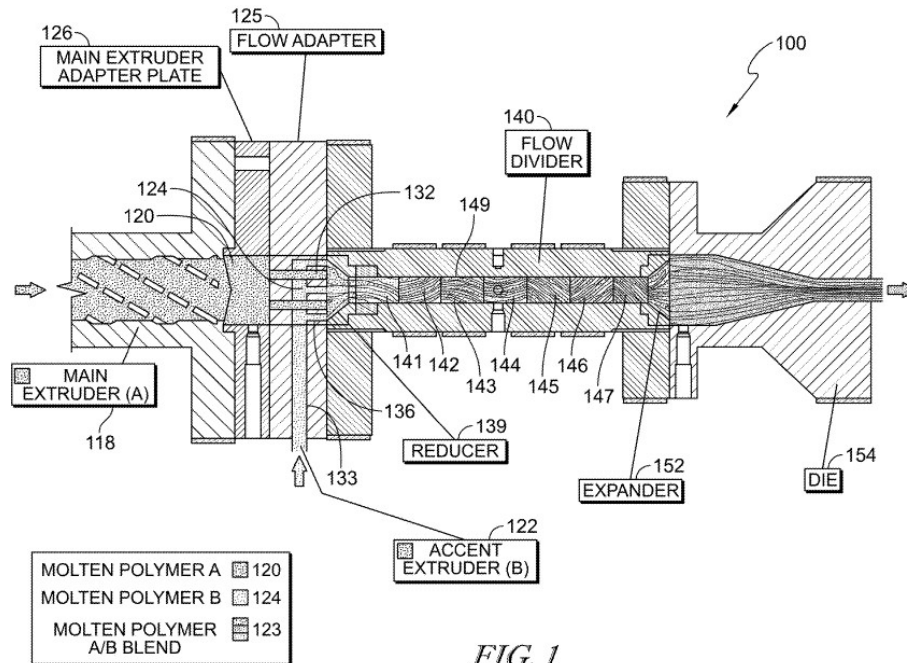
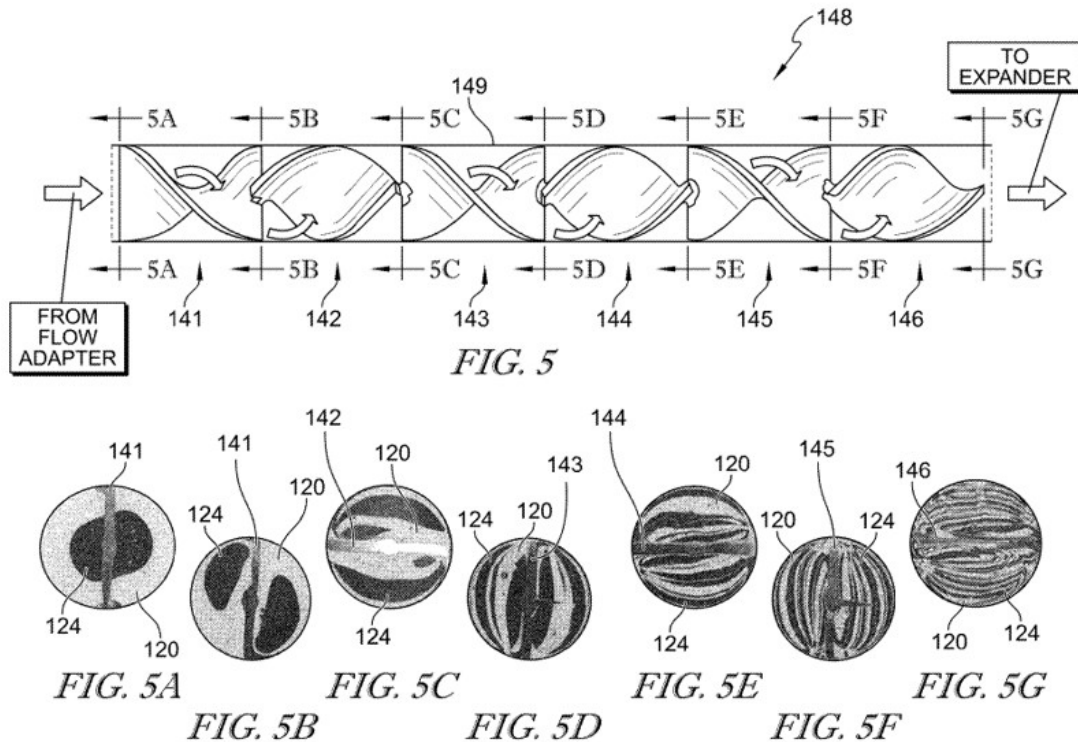


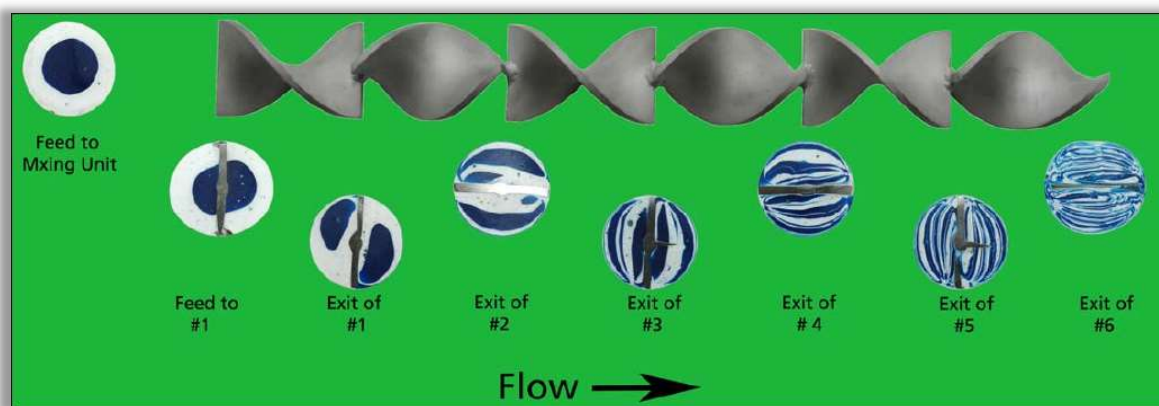
FIG. 1

45. A “flow adapter 125 is coupled to first extruder 118 by securing flow adapter 125 to an adapter plate 126.” RPI1001 at 4:43-45. Flow adapter 125 is “configured to initiate the combined flow of first and second polymers 120, 124 through extrusion machine 100.” RPI1001 at 4:45-49. The “combined flow of first and second polymers 120, 124 is then directed to flow divider 140 for formation of the wood grain pattern.” RPI1001 at 4:49-51. The flow divider 140 includes “a plurality of section inserts 141-147” that “are coupled to one another to form a continuous dividing element 148 as suggested in FIG. 5,” reproduced below. RPI1001 at 5:31-35.



46. In the '928 Provisional Application, to which it has been explained to me that the '350 patent claims priority and whose disclosure it incorporates by reference (RPI1001 at (60), 1:6-9), the "flow divider 140" is referred to as a "[s]tatic mixer 40." RPI1003 at ¶¶[0014], [0038-42]. The '928 Provisional Application further discloses that "[d]ifferent style static mixers can be used to create different grain patterns" and that "[p]referably helical static mixers are used as shown in Fig. 7" of the '928 Provisional Application, which corresponds to Figure 5 of the '350 patent (reproduced above). RPI1003 at ¶¶[0039], [0014] ("Fig. 7 is a perspective view of the mixing element inserts used in connection with the static mixer.")

47. I am informed that that figure was copied from Figure 20 of the StaMixCo prior art that I discuss further below and it does, in fact, appear to me to be the same:

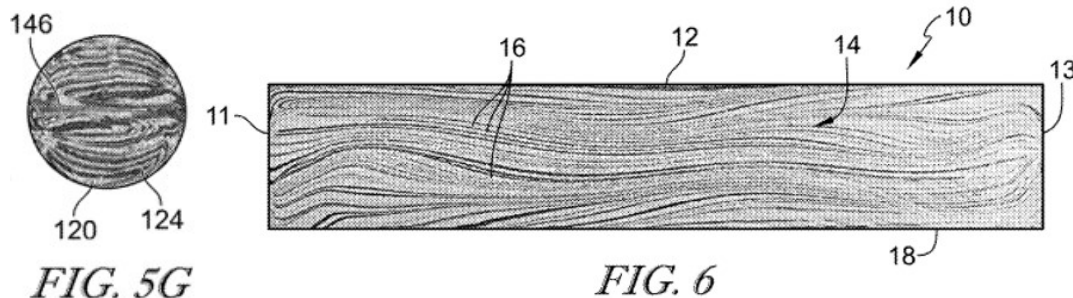


48. The '928 Provisional Application also explains that the “design, orientation and number of element inserts 41-47” in the static mixer “play a key role in determining the linear graining and streaking aesthetics for a particular profile size and shape.” *Id.* at ¶[0039].

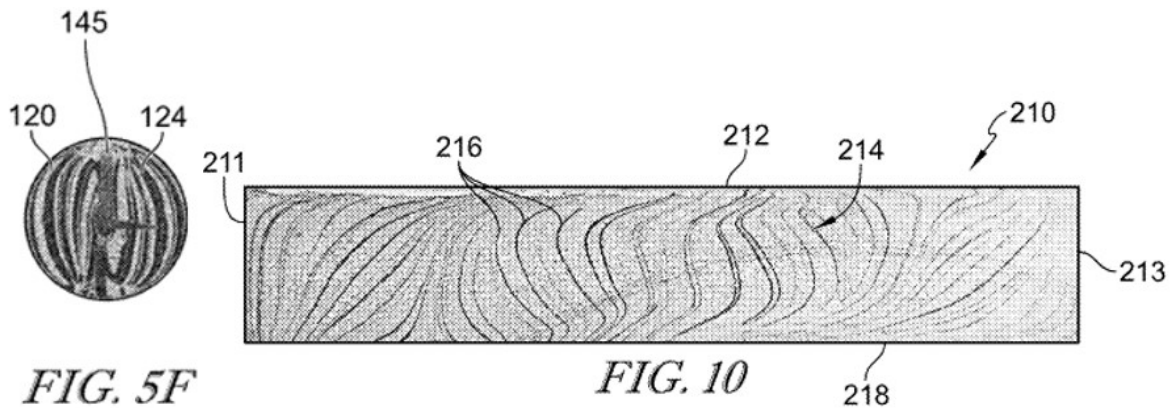
49. “In the illustrative embodiment” of the '350 patent (*see* Fig. 5, reproduced above), “each section insert 141-147 is a plate having opposing ends twisted relative to one another to form a helical profile,” with “[s]ection inserts 141-147 ... coupled to one another such that the helical profile along the combined dividing element is offset and reversed with each connected section insert 141-147.” RPI1001 at 5:35-41. The section inserts “cut across and redirect the combined flow of first and second polymer 120, 124 as the flow passes through channel 149 of flow

divider 140 as suggested in FIGS. 1 and 5-5G.” RPI1001 at 5:42-45. The section inserts “can be of different designs and fit together in a variety of orientations to vary the wood grain patterns 16 of polymer substrate 10.” RPI1001 at 5:46-48.

50. In the embodiment shown, “the design, orientation, and number of section inserts 141-147 *determine* the linear graining and layering aesthetics for a particular profile size and shape of polymer substrate 10.” RPI1001 at 5:58-61. For example, “as suggested in FIGS. 5 and 5G, a horizontal (longitudinal to the substrate) orientation in the final end of the dividing element 148 produces horizontal layers in the flow, which leads to horizontal grains in the final polymer substrate 10 as suggested in FIG. 6.” RPI1001 at 5:61-66; 6:24-43; 7:21-27.



51. On the other hand, “[h]aving the final end of the dividing element 148 oriented vertically produces vertical (transverse to the substrate) layers in the flow, which leads to vertical grains in the final polymer substrate 10 as suggested in FIG. 10.” RPI1001 at 5:66-6:3; 6:44-61; 7:27-33.



52. “With each successive section insert 141-147, the interlayering of first polymer 120 and second polymer 124 increases the amount of linear graining between the two polymers 120, 124” and the “continuous dividing and rotation of the flow causes layers of first and second polymer 120, 124 to form on one another within the flow rather than forming a homogenous mixture.” RPI1001 at 6:4-15.

53. “The combined flow of layered polymers 120, 124 exiting section insert 147 enters an expander 152 as shown in FIG. 1,” and the expander “directs the flow into the entry of a die 154 for forming the general profile of polymer substrate 10.” RPI1001 at 6:16-21. The substrate then “enters tooling with similar dimensions to the die exit to begin cooling and forming the final product.” RPI1001 at 6:21-6:23. “Various cross-sectional profiles are possible, such as round, polygonal, or other unique shapes” and these “profiles can be created using the die 154, or through post processing of the boards.” RPI1001 at 7:2-7.

C. Challenged Claims of the '350 Patent

54. I have been asked to review Claims 1-24 of the '350 patent. I have reproduced the challenged claims below.

Claim	Recitation
[1pre]	A simulated natural wood-grained polymer board having a first side and a second side spaced apart from the first side, the spacing between the first and second sides defining one of a width or a height of the board, the first and second sides extending along a length direction between a first end and a second end, the first and second ends defining a length of the board, the board comprising:
[1a]	a first set of polymer layers extending along the length direction and containing a first colorant, a majority of the first set of polymer layers extending along the length of the entire board;
[1b]	a second set of polymer layers extending along the length direction and containing a second colorant different than the first colorant, a majority of the second set of polymer layers extending along the length of the entire board; and
[1c]	wherein a plurality of individual layers of the first and second sets of polymer layers alternate within the board and extend along a substantially uninterrupted curvilinear path originating proximate the first side of the board and terminating proximate the second side of the board.
2	The board of claim 1, wherein the layers of the first set of polymer layers are thinner than the layers of the second set of polymer layers.

3	The board of claim 1, wherein a portion of at least one of the first side and second side of the board is removed to expose portions of the first and second sets of polymer layers along the length direction.
4	The board of claim 3, wherein the exposed portions of the first and second sets of polymer layers form a burled grain pattern.
5	The board of claim 1, wherein at least one of the first and second sides of the board is embossed with a wood grain pattern.
6	The board of claim 1, wherein the first and second sets of polymer layers are formed from high density polyethylene.
7	The board of claim 6, wherein the first and second sets of polymer layers further include at least one of a UV inhibitor and a foaming agent.
8	The board of claim 6, wherein one of the first and second sets of polymer layers further includes a foaming agent.
9	The board of claim 1, wherein the board is formed to define a polygonal cross-section along a length of the board.
[10pre]	A simulated natural wood-grained polymer substrate extending along a first direction, the substrate having a first side and a second side spaced apart from the first side along a second direction different than the first direction, the first and second sides defining a width of the substrate, the first and second sides extending along the first direction, a core of the substrate extending between the first and second sides and along the first direction, the substrate comprising:

[10a]	a first set of polymer layers extending along the first direction and containing a first colorant, a majority of the first set of polymer layers being substantially continuous along the first direction; and
[10b]	a second set of polymer layers extending along the first direction and containing a second colorant different than the first colorant, a majority of the second set of polymer layers being substantially continuous along the first direction;
[10c]	wherein individual layers of the first and second sets of polymer layers alternate within the core of the substrate to form a natural wood-grained appearance throughout the core of the substrate; and
[10d]	wherein a plurality of the individual layers of one of the first and second sets of polymer layers extend along a substantially uninterrupted curvilinear path in the second direction originating proximate the first side and terminating proximate the second side.
11	The substrate of claim 10, wherein the layers of the first set of polymer layers are thinner than the layers of the second set of polymer layers.
12	The substrate of claim 10, wherein the first and second sets of polymer layers are formed from high density polyethylene.
13	The substrate of claim 12, wherein the first and second sets of polymer layers further include at least one of a UV inhibitor and a foaming agent.
14	The substrate of claim 12, wherein one of the first and second sets of polymer layers further includes a foaming agent.
15	The substrate of claim 10, wherein the substrate is formed to define a polygonal cross-section along a length of the substrate.

16	The board of claim 6, wherein the core is substantially free of natural wood materials.
17	The board of claim 1, further comprising a third side and a fourth side spaced apart from the third side along a height direction different than the length direction and width direction, wherein the third and fourth sides define a height of the board, wherein the third and fourth sides extend along the length direction between the first and second ends, wherein the core of the board extends between the first, second, third, and fourth sides and between the first and second ends, and wherein the individual layers of the first and second sets of polymer layers alternate within the core of the board along the height direction.
18	The substrate of claim 12, wherein the core is substantially free of natural wood materials.
19	The substrate of claim 10, further comprising a third side and a fourth side spaced apart from the third side along a third direction different than the first and second directions, wherein the third and fourth sides define a height of the substrate, wherein the third and fourth sides extend along the first direction, wherein the core of the substrate extends between the first, second, third, and fourth sides and along the first direction, and wherein individual layers of the first and second sets of polymer layers alternate within the core of the substrate along the third direction.
[20pre]	A simulated natural wood-grained polymer substrate having a length defined along a first direction, a width defined along a second direction perpendicular to the first direction, and a height defined along a third

	direction perpendicular to both the first and second directions, the substrate comprising:
[20a]	a first set of polymer layers extending along the first direction and containing a first colorant, a majority of the first set of polymer layers being substantially continuous along the first direction; and
[20b]	a second set of polymer layers extending along the first direction and containing a second colorant different than the first colorant, a majority of the second set of polymer layers being substantially continuous along the first direction;
[20c]	wherein individual layers of the first and second sets of polymer layers alternate within the substrate along the third direction to form a natural wood-grained appearance throughout the substrate; and
[20d]	wherein a plurality of the individual layers of one of the plurality of the first and second sets of polymer layers extend along a substantially uninterrupted curvilinear path in the second direction originating proximate an outer surface of a first portion of the substrate and terminating proximate an outer surface of a second portion of the substrate.
21	The substrate of claim 20, wherein the layers of the first set of polymer layers are thinner than layers of the second set of polymer layers.
22	The substrate of claim 20, wherein the first and second sets of polymer layers are formed from high density polyethylene.
23	The substrate of claim 22, wherein the core is substantially free of natural wood materials.
[24pre]	A simulated natural wood-grained polymer board comprising:

[24a]	a polymer core having a first side and a second side spaced apart from the first side, spacing between the first and second sides defining one of a width or a height of the core, the first and second sides extending along a length direction of the core between a first end and a second end, the first and second ends defining a length of the core;
[24b]	a first set of polymer layers extending along the length direction and containing a first colorant, a majority of the first set of polymer layers extending along the entire length of the core;
[24c]	a second set of polymer layers extending along the length direction and containing a second colorant different than the first colorant, a majority of the second set of polymer layers extending along the entire length of the core; and
[24d]	wherein a plurality of individual layers of the first and second sets of polymer layers alternate within the core and extend along a substantially uninterrupted curvilinear path originating from proximate the first side of the core and terminating proximate the second side of the core.

55. After my review, I understand that each of independent **Claims 1, 10, 20, and 24** are generally directed to a “simulated natural wood-grained polymer board” (**Claims 1 and 24**) or “simulated natural wood-grained polymer substrate” (**Claims 10 and 20**) having two alternating sets of differently-colored polymer layers that extend through each board or substrate along specific dimensions. The substrate

of **Claim 10** and the board of **Claim 24** are expressly recited to include a “core” or “polymer core,” respectively.

56. The claimed board of **Claim 1** and the polymer core of the board of **Claim 24** has a “first side and a second side spaced apart from the first side, [the (**Claim 1**)] spacing between the first and second sides defining one of a width or a height of the” board or core, “the first and second sides extending along a length direction [of the core (**Claim 24**)] between a first end and a second end, the first and second ends defining a length of the” board or core. Similarly, the substrate of **Claim 10** is recited as “extending along a first direction, the substrate having a first side and a second side spaced apart from the first side along a second direction different than the first direction, the first and second sides defining a width of the substrate, the first and second sides extending along the first direction, a core of the substrate extending between the first and second sides and along the first direction.” The substrate of **Claim 20** is described as having the same spatial elements, and is recited as “having a length defined along a first direction, a width defined along a second direction perpendicular to the first direction, and a height defined along a third direction perpendicular to both the first and second directions.”

57. The claimed board of **Claims 1** and **24** each further comprises “a first set of polymer layers extending along the length direction and containing a first

colorant, a majority of the first set of polymer layers extending along the [entire **(Claim 24)]** length of the [entire **(Claim 1)]**” board **(Claim 1)** or core **(Claim 24)** and “a second set of polymer layers extending along the length direction and containing a second colorant different than the first colorant, a majority of the second set of polymer layers extending along the [entire **(Claim 24)]** length of the [entire **(Claim 1)]**” board **(Claim 1)** or core **(Claim 24)**. The substrates of **Claims 10** and **20** similarly comprise “a first set of polymer layers extending along the first direction and containing a first colorant, a majority of the first set of polymer layers being substantially continuous along the first direction” and “a second set of polymer layers extending along the first direction and containing a second colorant different than the first colorant, a majority of the second set of polymer layers being substantially continuous along the first direction.”

58. The claimed boards of **Claims 1** and **24** further require that “a plurality of individual layers of the first and second sets of polymer layers alternate within the” board **(Claim 1)** or core **(Claim 24)** “and extend along a substantially uninterrupted curvilinear path originating proximate the first side of the” board **(Claim 1)** or core **(Claim 24)** “and terminating proximate the second side of the” board **(Claim 1)** or core **(Claim 24)**. Similarly, the claimed substrates of **Claims 10** and **20** require that the “individual layers of the first and second sets of polymer

layers alternate within the [core of the (**Claim 10**)] substrate [along the third direction (**Claim 20**)] to form a natural wood-grained appearance throughout the [core of the (**Claim 10**)] substrate” and that “a plurality of the individual layers of one of the [plurality of the] first and second sets of polymer layers extend along a substantially uninterrupted curvilinear path in the second direction originating proximate [the first side and terminating proximate the second side (**Claim 10**) / an outer surface of a first portion of the substrate and terminating proximate an outer surface of a second portion of the substrate (**Claim 20**)].”

59. **Claims 17 and 19**, which I understand depend from **Claims 1 and 10**, respectively, recite a third dimension to the claimed board and substrate. Specifically, **Claims 17 and 19** additionally recite that the claimed board and substrate further comprises “a third side and a fourth side spaced apart from the third side along a [height (**Claim 17**) / third (**Claim 19**)] direction different than the [length direction and width direction (**Claim 17**) / first and second directions (**Claim 19**)], wherein the third and fourth sides define a height of the [board (**Claim 17**) / substrate (**Claim 19**)], wherein the third and fourth sides extend along the [length (**Claim 17**) / first (**Claim 19**)] direction [between the first and second ends (**Claim 17**)], wherein the core of the [board (**Claim 17**) / substrate (**Claim 19**)] extends between the first, second, third, and fourth sides [and between the first and second

ends (**Claim 17**) / and along the first direction (**Claim 19**)], and wherein the individual layers of the first and second sets of polymer layers alternate within the core of the [board (**Claim 17**) / substrate (**Claim 19**)] along the [height (**Claim 17**) / third (**Claim 19**)] direction.”

60. Figures 6 and 10 help visualize these claims, as annotated below:

Figure 6 (annotated)

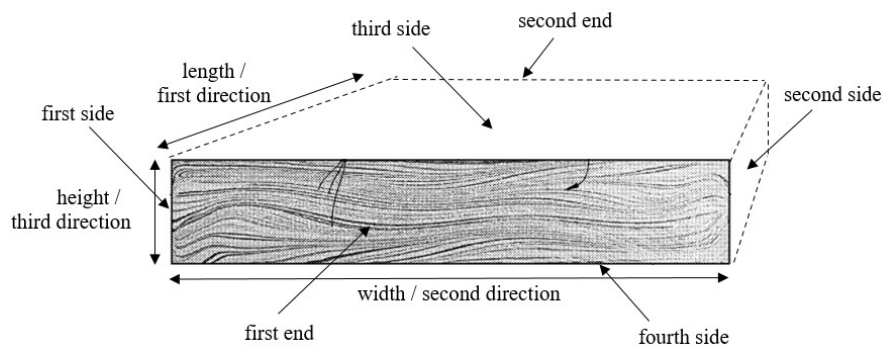
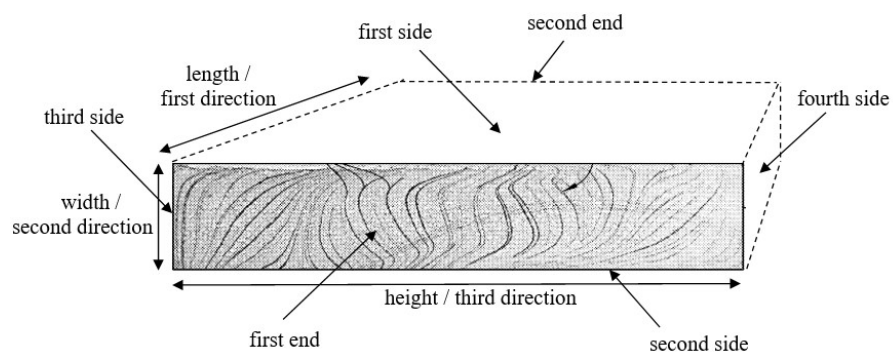


Figure 10 (annotated)



61. Dependent **Claims 2, 11, and 21**, which I understand depend from **Claims 1, 10, and 20**, respectively, each additionally require that the “layers of the

first set of polymer layers are thinner than the layers of the second set of polymer layers.”

62. My understanding is that **Claim 3** depends from **Claim 1** and requires additionally that “a portion of at least one of the first side and second side of the board is removed to expose portions of the first and second sets of polymer layers along the length direction.” **Claim 4**, in turn, depends from **Claim 3**, and additionally requires that “the exposed portions of the first and second sets of polymer layers form a burled grain pattern.”

63. **Claim 5**, which I understand depends from **Claim 1**, additionally recites that “at least one of the first and second sides of the board is embossed with a wood grain pattern.”

64. **Claims 6, 12, and 22**, which I understand depend from **Claims 1, 10, and 20**, respectively, additionally require that “the first and second sets of polymer layers are formed from high density polyethylene.” **Claims 7 and 13**, in turn, depend from **Claims 6 and 12**, respectively, and further require that “the first and second sets of polymer layers further include at least one of a UV inhibitor and a foaming agent.” **Claims 8 and 14** also depend from **Claims 6 and 12**, respectively, and additionally require that “one of the first and second sets of polymer layers further includes a foaming agent.”

65. My understanding is that **Claims 9 and 15** depend from **Claims 1 and 15**, respectively, and further require that each of the board (of **Claim 1**) and the substrate (of **Claim 10**) “is formed to define a polygonal cross-section along [its] length.”

66. My understanding is that **Claims 16, 18, and 23** depend from **Claims 6, 12, and 22**, respectively, and additionally recite that “the core is substantially free of natural wood materials.”

D. File History of the '350 Patent

67. It has been explained to me that U.S. Patent Application No. 15/245,948 (“the '948 Application”) was filed on August 24, 2016, and resulted in U.S. Patent No. 10,981,350. The '948 Application claims priority to the '928 Provisional Application.

68. It is my understanding that in an Office Action dated December 15, 2017, the Examiner rejected most of the pending claims, claims 1, 3-10, and 12-16, over a single prior art reference, “Rohatgi” (US 2003/0021915), and the remaining two pending claims, claims 2 and 11, over Rohatgi in view of a second reference, “Franco” (US 2004/0038002). RPI1004 at 110-18.

69. I understand that Applicants responded by attempting to distinguish Rohatgi as being “directed to techniques for ‘encapsulation’ that provide different properties to the ‘skin and core’ rather than the formation of different colored layers”

and as using “‘streaking’ techniques” that “produce short ‘streaks’ in the composite product instead of continuous lines.” RPI1004 at 164-65. They further argued that Franco did not remedy these alleged shortcomings. *Id.* My understanding is that, in a subsequent interview with the Examiner on April 20, 2018, Applicants

discussed the invention in detail including the process of forming the simulated wood substrate and how the process differs from that of the prior art such that the prior art gives the simulated wood substrate of Rohatgi short streaks of polymer materials due to the pellets in the process instead of the longer streaks of applicant’s invention. Additionally, the discussion revolved around how the applicant could submit claim amendments that further differentiate the invention from figure 3 of Rohatgi such that the end of the simulated wood includes stacked polymer layers terminating at the width ends of the board rather than a swirl.

RPI1004 at 174.

70. Following that interview, on May 21, 2018, Applicants amended their pending claims “to require the plurality of individual layers of the first and second sets of polymer layers to alternate within the board and extend along a substantially uninterrupted curvilinear path originating proximate the first side of the board and

terminating proximate the second side of the board,” which they argued overcame the prior art. RPI1004 at 186.

71. I understand that the Examiner once again rejected all pending claims notwithstanding this amendment, in an Office Action dated July 13, 2018. RPI1004 at 195-225. My understanding is that the Examiner found the pending claims to be unpatentable in view of a single prior art reference, “Piedboeuf” (US 7,204,944), on its own (claims 1, 10, 21, and 25) and/or in view of other prior art references, “Sudano” (US 2011/0177291), Rohatgi, and/or Franco. *Id.*

72. With respect to Piedboeuf, the Examiner found that “Piedboeuf teaches processes for creating color effects in extrudable material” and that the process includes the steps of providing a first and a second stream of viscous materials of different colors and combining those streams feeding them into a helical static mixer, shown in Fig. 3 (Col. 1, Lines 49-63). The system additionally includes a die, a feed block, and at least two extruders as shown below with the static mixer (Col. 1, Lines 64-66; Fig. 1).

RPI1004 at 199.

73. The Examiner reproduced Figures 1 and 3 of Piedboeuf, which illustrate the point:

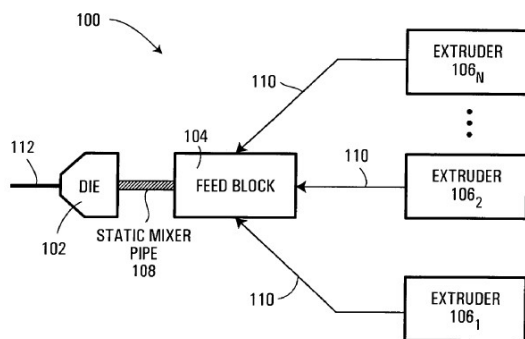


FIG. 1



FIG. 3

RPI1004 at 200.

74. The Examiner further noted that “the system taught by Piedboeuf is *nearly identical* to the system which forms the simulated natural wood-grained polymer board as claimed by the applicant in that the system as defined by applicant’s specification is formed by the input of two different materials having two differing colors which are then mixed through a static mixer similar to the one shown above taught by Piedboeuf, and then extruded to form the board as shown in Figures 1 and 5-5G.” RPI1004 at 201. The Examiner also stated that “processing two polymer materials having differing colors taught by Piedboeuf would ultimately result in the [sic] in a plastic sheet having the shape of a board” and would have the layers required by the pending claims. RPI1004 at 201. Further, the Examiner stated that it would have been obvious “to form an extruded product ... which may have a wood grain appearance for aesthetics depending on the user.” RPI1004 at 202.

75. It has been explained to me that an interview between Applicants and the Examiner followed on August 3, 2018, in which Applicants argued that “the process taught in Piedboeuf was ultimately to create a gradient pointing to figure 6a of Piedboeuf” but “no agreement was reaching concerning this such that Piedboeuf appreciates a sharp transition between bands in addition to a slow gradation and the bands may be straight or wavy depending on the process parameters.” RPI1004 at 241.

76. It has been further explained to me that Applicants submitted a Response to the prior Office Action rejecting their claims on September 13, 2018. RPI1004 at 242. There, my understanding is that Applicants argued in response to the Examiner’s discussion of Piedboeuf’s process that “no process is currently claimed, and, rather, ‘simulated natural wood-grained polymer’ boards and substrates of particular structure are claimed.” RPI1004 at 250; *see also* RPI1004 at 251 (“no process is presently claimed and should not be seen as limiting of the currently pending claims”). Applicants also took issue with the Examiner’s finding that the process described in Piedboeuf “would ultimately result” in the claimed structures of the pending claims on the purported basis that “the cited references fail to show these specific structures.” RPI1004 at 250. Thus, Applicants argued that the Office Action “fails to describe how one skilled in the art could arrive at the claimed

structures simply by reviewing the processes of the cited references without undue experimentation or the benefit of hindsight bias from the disclosure of the present application” which Applicants argued to be the “only” teaching of the claimed structures. RPI1004 at 250-51.

77. I understand that the Examiner once again rejected all pending claims in an Office Action dated January 2, 2019, citing the same prior art as in the previous Office Action. RPI1004 at 255-85. The Examiner further responded to Applicants’ arguments by noting “that while what is being claimed is a product, during examination of the product, a process of forming the product may be relevant in determining obviousness.” RPI1004 at 282. It is also my understanding that the Examiner further reiterated the identity of the process disclosed in Piedboeuf to the one disclosed by Applicants and found that it “would therefore result in the two-toned extrudate as described by” Applicants. RPI1004 at 283. The Examiner also noted that Piedboeuf not only teaches products having “gradual transitions,” as Applicants argued, but also ones where the “colors may have sharps transitions.” RPI1004 at 283. The Examiner additionally noted that where “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.” RPI1004 at 283.

78. I understand that Applicants thereafter filed a notice of appeal on March 4, 2019, and in their Pre-Appeal Brief Conference Request and Reasons in Support submitted on the same day largely repeated their prior arguments regarding Piedboeuf. RPI1004 at 297-302. Further, on August 23, 2019, Applicants filed their appeal, largely repeating their previous arguments regarding Piedboeuf yet again. RPI1004 at 323-41. They also argued that their disclosed process differs from the Piedboeuf process in that the flow adapter, which directs the flow of polymers into the static mixer, is different in each. RPI1004 at 334.

79. I further understand that the Examiner filed his response on September 20, 2019, defending his previous opinions. RPI1004 at 352-85. My understanding is that he also addressed Applicants' new argument regarding purported differences in the disclosed flow adapters of their application and of Piedboeuf by noting that the flow adapters do not "appear to contribute to the 'wood-grained' appearance of the polymers." RPI1004 at 380. Instead, the Examiner noted, "[t]his features [sic] appears to be dependent upon the helical mixer illustrated in figures 5A-5G." RPI1004 at 380.

80. It has been explained to me that the Patent Trial and Appeal Board ("PTAB") issued a decision on December 11, 2020, in which it reversed the Examiner's rejection of all pending claims. RPI1004 at 392-98. I understand that, in

so doing, the PTAB found that the Examiner did “not establish that Piedboeuf’s products, merely due to having multiple bands with color variation, are equivalent to the Appellant’s simulated natural wood grained products.” RPI1004 at 396. My understanding is that the PTAB further found that the Examiner did not establish that “Piedboeuf would have suggested forming the streams of viscous material such that the product has that [wood simulated wood grain] appearance” or “how one of ordinary skill in the art would have carried out Piedboeuf’s process in a way that produces a product having a simulated wood grain appearance.” RPI1004 at 396. It has been explained to me that the Examiner thereafter issued a Notice of Availability based on the PTAB’s decision, on January 7, 2021. RPI1004 at 403-05.

81. I understand that Applicants never mentioned during prosecution of the ’350 patent that the disclosure contained in Figure 5 was copied from the StaMixCo prior art. I further understand that the only time StaMixCo was ever mentioned was when a two-page StaMixCo webpage printout was provided by Applicants in an Information Disclosure Statement filed on February 27, 2018, nearly three years after they included the StaMixCo image in Figure 7 of the ’928 Provisional Application. RPI1004 at 131.

82. Moreover, I have not seen any discussion by Applicants or the Examiner of the contents of either the StaMixCo webpage, or of the StaMixCo prior art, in the file history and understand that there is not any.

83. Instead, as I described above, I understand that Applicants continued to argue that their specification is the “only” teaching of the claimed structures, even after eventually identifying the StaMixCo webpage in their Information Disclosure Statement.

E. Claim Construction

84. I understand that before assessing the validity of a patent, the claim language must be properly construed to determine its scope and meaning in order to be able to compare it to the prior art.

85. For purposes of my analysis, the only term that I believe requires claim construction is “**burled grain pattern.**”

86. This term appears in **Claim 4**, which depends from **Claim 3** (which in turn depends from **Claim 1**):

3. The board of claim 1, wherein a portion of at least one of the first side and second side of the board is removed to expose portions of the first and second sets of polymer layers along the length direction.
4. The board of claim 3, wherein the exposed portions of the first and second sets of polymer layers form a burled grain pattern.

87. The specification does not define a “burled grain pattern” anywhere and only once refers to a “burling effect.” It does so when explaining that “a thin layer can be removed from each outer surface 12” of the claimed substrate or board, “such as by planing, to expose the wood grain pattern 16 as suggested in FIG. 9. In the illustrative embodiment, a burling effect is created due to the horizontally oriented and closely spaced grains 16.” RPI1003 at 6:39-43. Figure 9, showing the supposed “burling effect,” is reproduced below:

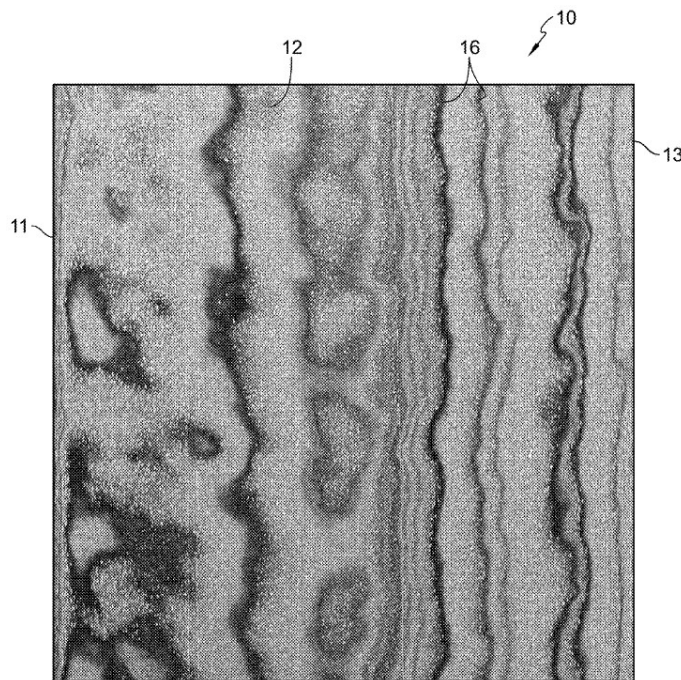
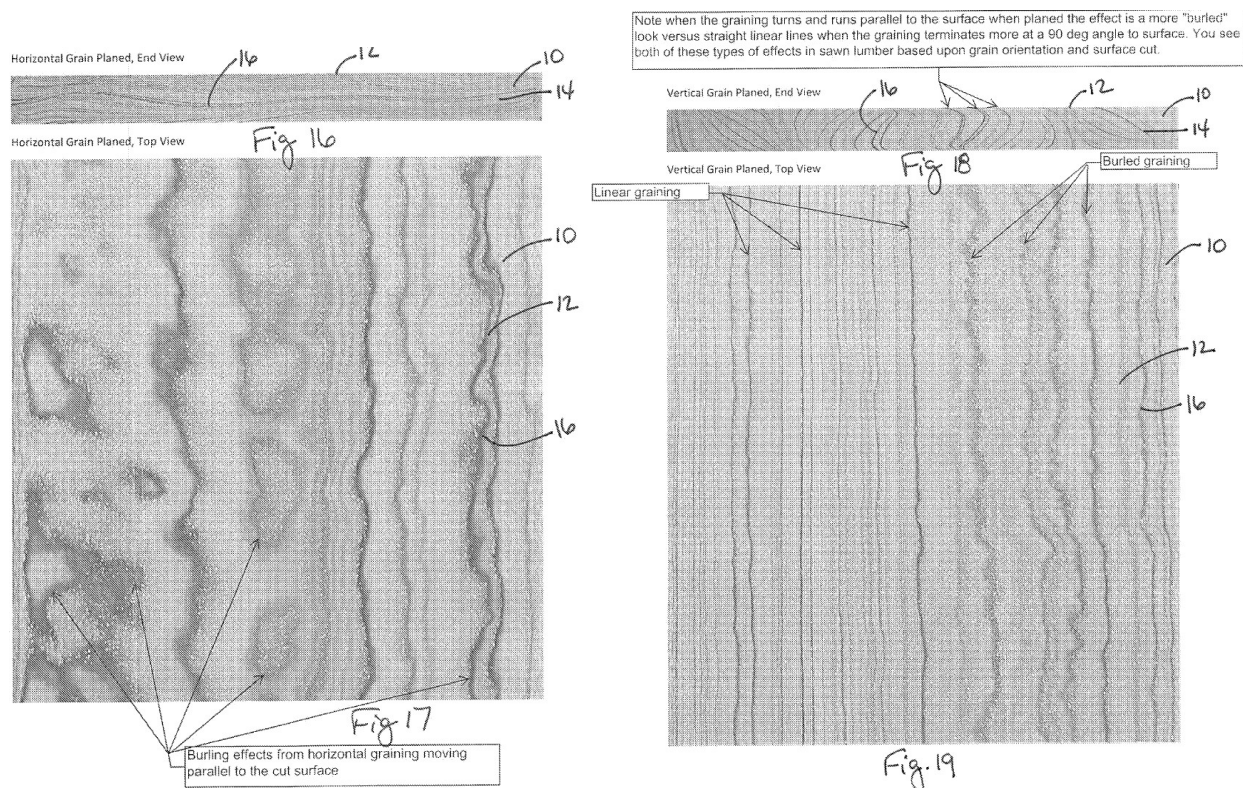


FIG. 9

The specification explains that Figure 9 is a view “showing a wood grain pattern of the polymer substrate after a portion of the outer surface is removed.” RPI1003 at 3:1-3.

88. The '928 Provisional Application, which the '350 patent incorporates by reference, likewise does not define a “burled grain pattern.” Instead, it similarly points to examples of “burling effects from horizontal graining moving parallel to the cut surface” in Fig. 17 and of “burled graining effects from planning the surface of the board” in Fig. 19 (RPI1003 at [0024], [0026]):



89. The notes to Figures 18 and 19 in the '928 Provisional Application further explain that “when the graining turns and runs parallel to the surface when planed the effect is a more ‘burled’ look versus straight linear lines when the graining terminates more at a 90 deg angle to surface.” RPI1003 at 10. The prosecution

history of the '350 patent does not contradict these descriptions in the specification or otherwise further define a “burled grain pattern.”

90. It is therefore my opinion that a person of ordinary skill in the art would have understood a “burled grain pattern” to mean a “grain pattern resulting from planing the surface.”

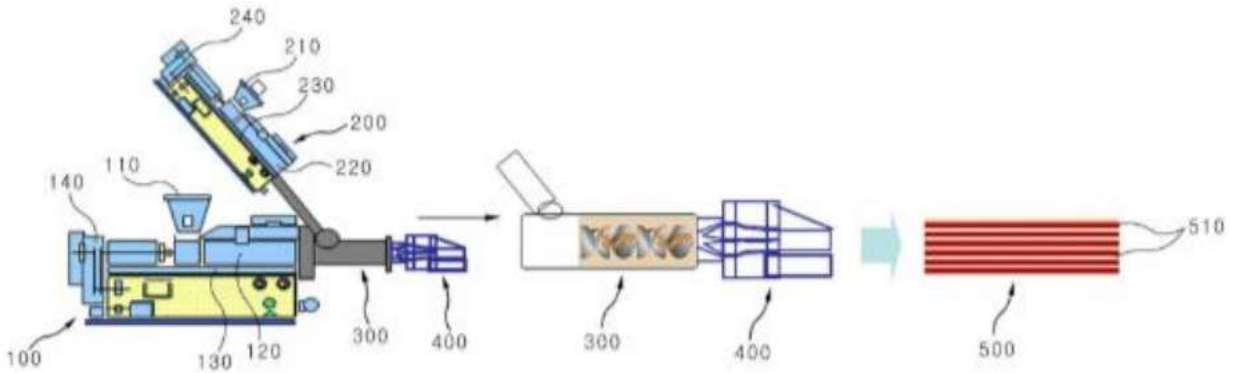
91. I did not consider the construction of any remaining terms in this patent, which I find unnecessary for purposes of my analysis in view of the prior art that I analyze below and its disclosures.

92. I have not been asked to opine, and offer no opinion, regarding whether any of those remaining claim terms sufficiently inform, with reasonable certainty, those skilled in the art about the scope of the invention outside of the context of the prior art I analyze below.

VII. Overview of the Prior Art

A. Nam (RPI1011) – Korean Patent No. 10-1338611

93. Nam discloses a “manufacturing apparatus and method of synthetic wood having striped grain, and synthetic wood manufactured from the same, configured such that it has striped grain on both the surface and interior of a two-color, heterogeneous mixture.” RPI1011 at [0001]. In Figure 3, Nam discloses the method and apparatus for making such synthetic wood:



Id. at Fig. 3, [0017], [0020-21], [0027].

94. Nam is directed to “plastic” and “petrochemical” products and raw materials, and the improvement thereof. *Id.* at [0005], [0007], [0018]. Nam additionally teaches that polymer mixtures of two different colors are melted in two separate hoppers, and each is extruded via an extrusion screw into a static mixer. *Id.* at [0011-12], [0014-15], [0020-25]. As shown in Figure 3, the static mixer is helical, with alternating rectangular plate elements “being twisted 180-degrees on the flow path of the resin.” *Id.* at [0018]. As the melted material passes through each element of the mixer, it is formed into alternating layers:

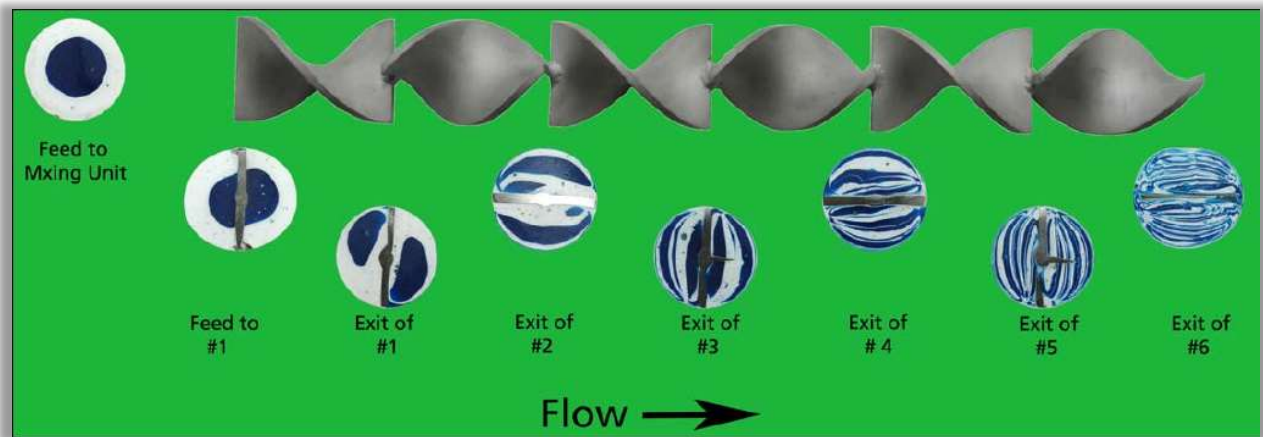
Number of elements	1	2	3	4	5
Partition figure					
Number of partitions	2	4	8	16	32

Id. at Fig. 2. Nam teaches that this mixing results in a striped grain like that on real wood. *Id.* at [0015], [0020], [0026-27]. The melted material is then molded via a “die or mold” into a board that has the striped grain on the surface and interior. *Id.* I also note that Nam discloses that follow-up processing like drying and cutting can be performed on the synthetic wood. *Id.* at [0027].

95. I understand that Nam is a Korean patent that was filed in Korea on November 12, 2009, and was published on December 6, 2013. It has been explained to me that Nam is considered prior art since it is a patent that was issued prior to August 24, 2015—the earliest priority date of the ’350 patent.

B. StaMixCo (RPI1010) – SMB Extrusion Melt Blender

96. StaMixCo discloses several static mixer designs used for extrusion. These static mixers are expressly disclosed for use in “the extrusion of viscous polymers ... and other materials.” RPI1010 at 1. StaMixCo teaches that its static mixers are “installed just in front of the extruder die.” RPI1010 at 2. StaMixCo further teaches that before entering the die, “[m]olten polymer, driven by the screw, flows through the static mixer,” which continuously divides and recombines the material as it flows through the static mixing elements. RPI1010 at 2. One of those static mixers, “SMB-H”, is a helical static mixer, illustrated below:

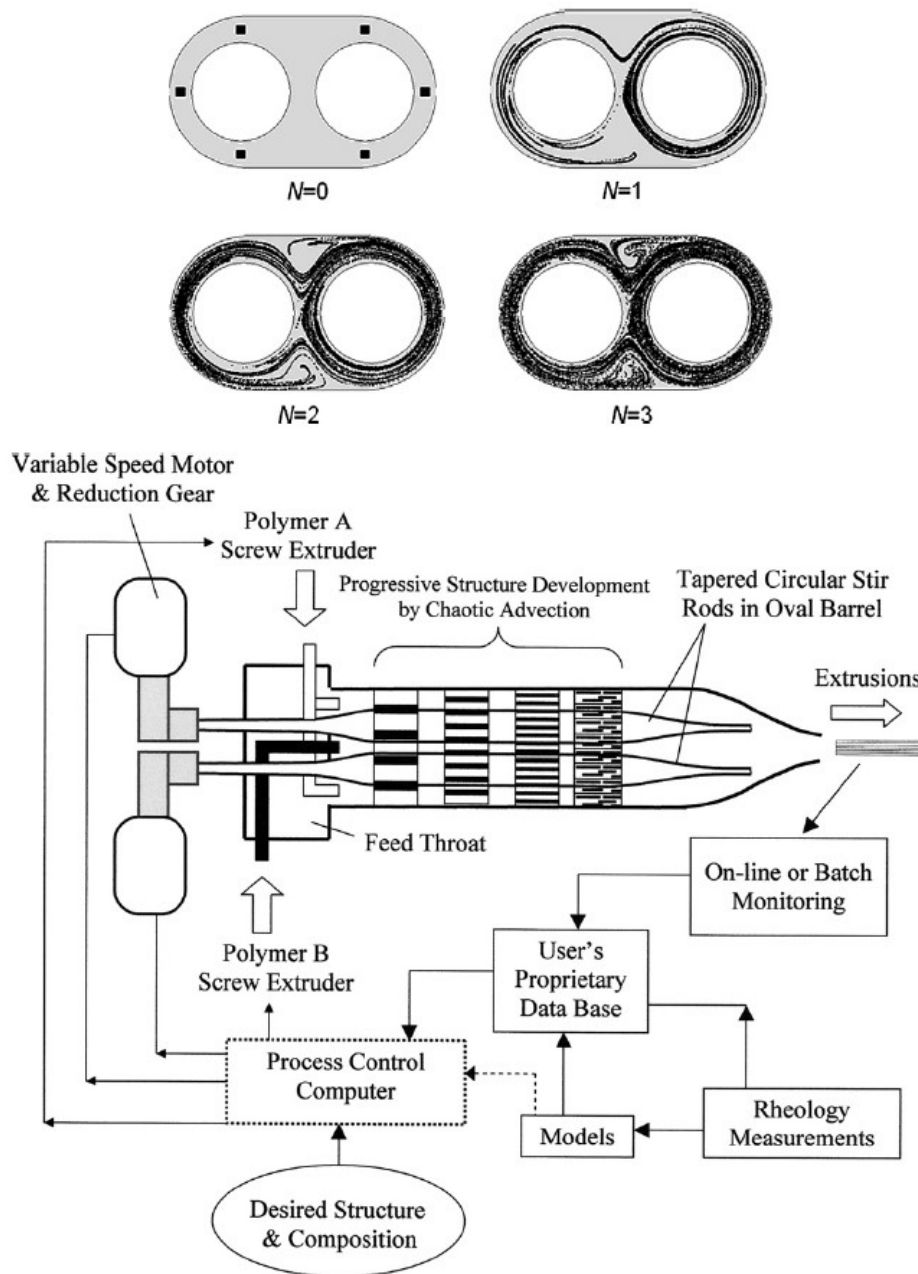


RPI1010 at Fig. 20; *see also id.* at 10. The above Figure appears to be identical to what has been described as the “key” Figure 5 of the ’350 patent. StaMixCo explains that Figure 20 illustrates “[b]lue and white viscous resin ... [being] pumped through six (6) SMB-H static mixing elements, allowed to harden and cross-sectional cuts are made at the outlet of each mixing element.” *Id.* The Figure above illustrates that the melt contains progressively more layers as it passes each successive mixing element. *Id.* The differently colored layers alternate with one another in either a horizontal or vertical orientation, which a person of ordinary skill in the art would understand from the disclosure to depend on the orientation of the last mixing element through which the melt passed. *Id.* StaMixCo explains that this design pioneered the static mixing industry and had been used on extruders for over 37 years. *Id.* at 10.

97. I understand that StaMixCo is a product brochure that was copyrighted in 2007, displays a version date of February 9, 2007, and was publicly available for download from the <http://stamixco-usa.com> website since as early as February 19, 2009. It has been explained to me that StaMixCo is considered prior art since it is a printed publication that predates August 24, 2015—the earliest priority date of the '350 patent.

C. Zumbrunnen (RPI1012) – Chaotic Advection and Its Application to Extruding Micro- and Nanostructured Plastic Materials

98. Zumbrunnen discloses using extrusion to create various “plastic products,” including ones “with the appearance of realistic wood grains both inside and on surfaces of the extrusions.” RPI1012 at 401. Rather than using a static mixer, Zumbrunnen teaches that stir rods could be used in its place in an extrusion process in order to “instill[] chaotic advection principally within planes parallel to the cross-section” of the blender’s barrel:

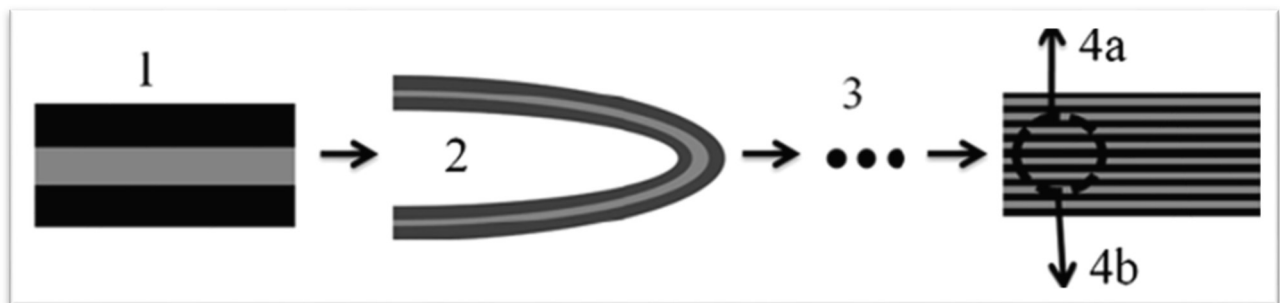


Id. at 404, Fig. 22.2.

99. With reference to Fig. 22.2 above, Zumbrunnen teaches that “[p]olymer melts are supplied to a feed throat of the smart blender by screw extruders in prescribed proportions to give a desired composition in the extrusion.” *Id.* at 403.

“The melts enter a region in the blender where chaotic advection is induced by time-periodic changes in rotational speeds of stir rods controlled by a process control computer” and “[a]s melt advances along the stir rods, melt domains are stretched and folded recursively by chaotic advection so that a layered arrangement first arises.” *Id.* “Thick multilayers reduce in thickness as stretching and folding progress and the melt moves toward an extrusion point.” *Id.*

100. Zumbrunnen further explains, with reference to Figure 22.1, reproduced below, that by “subjecting melts to chaotic advection, initially large melt domains (e.g., resin pellet size or larger) or melt streams are stretched and folded (steps 1—3) into alternating multilayers,” with “[s]uch stretching and folding [being] characteristic of chaotic advection.” *Id.* at 402.



Id. at Fig. 22.1; *see also id.* at 402. These processes can result in numerous structure types—any of which can be captured in an extrusion. *Id.* at 403. “At the extrusion point, the melt is formed by an attached die into a desired extrusion form such as a film, plate, or filament.” *Id.*

101. Zumbrunnen provides examples of mixtures and materials that can be used in its process. It teaches that its process “can be used with existing polymer resins.” *Id.* at 401. High density polyethylene (HDPE) is one of the specific polymer resins disclosed for use with Zumbrunnen’s teachings. *Id.* at 408.

102. Zumbrunnen further discloses that chaotic advection can produce extrusions with an infinite variety of appearances, including that of “simulated wood grains,” as shown in Figure 22.12:



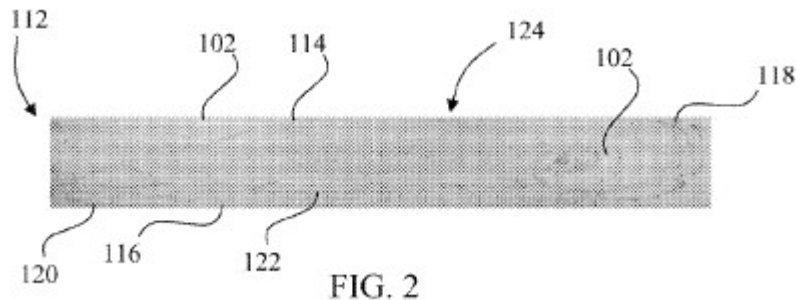
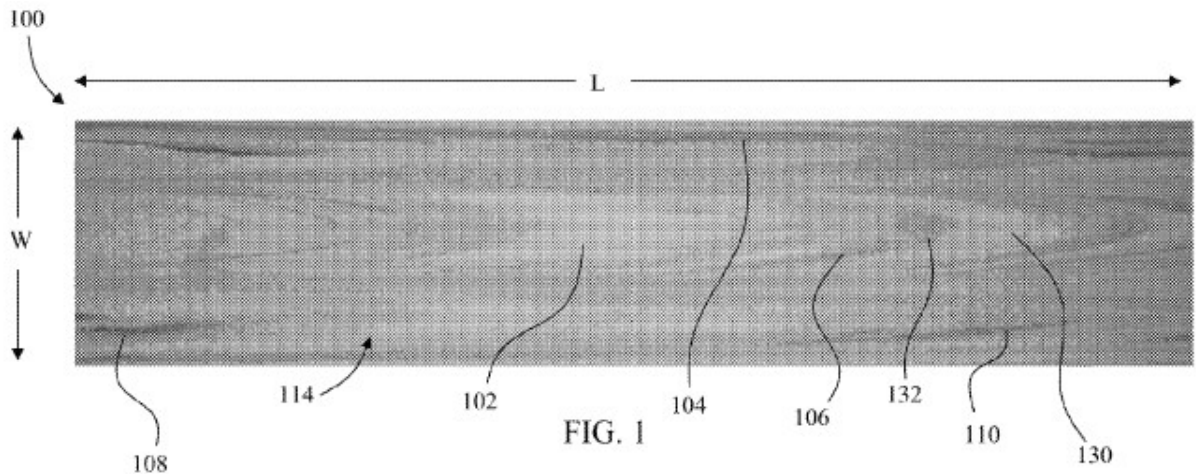
RPI1012 at Fig. 22.12; *id.* at 412-13. A wood grain pattern is formed “[b]y extruding th[e] structured melt through a die.” *Id.* at 413. Zumbrunnen further teaches that “[d]esired colors are obtained by using pigmented polymer resins such as those from colorant manufacturers intended specifically to impart wood appearance.” *Id.* at 413.

Zumbrunnen discloses that, “[l]ike cut wood, the simulated grain appears both on the surface and interior of extrusions.” *Id.* at 413.

103. Zumbrunnen is an academic paper published in December 2011. It has been explained to me that Zumbrunnen is considered prior art since it is a printed publication that predates August 24, 2015—the earliest priority date of the ’350 patent.

D. Rassi (RPI1013) – U.S. Patent No. 9,527,341

104. Rassi discloses an “extruded board with realistic appearance.” RPI1013 at Title. It describes the goal of its disclosure as creating “a board which presents a realistic look similar to the look of natural wood.” *Id.* at 1:57-58. Rassi teaches that its board is made using an extrusion process. *Id.* at 6:13-14. Rassi further teaches that the board is made by extruding a base resin along with colored streak portions to give the appearance of natural wood. RPI1013 at 1:66-2:6, 5:63-65. A top view of the board is shown in Figure 1 and a cross-section is shown in Figure 2, reproduced below:



105. Rassi teaches that its extruded simulated wood board includes additives like foaming agents and UV stabilizers. *Id.* at 6:36-42. Rassi discloses that different patterns can be realized on the board, including areas with a burlled appearance. *Id.* at 5:12-14. It further discloses that grain-like patterns can be embossed on the outer surface. *Id.* at 6:6-10. It also teaches that, once extruded, the board can be cut and fastened like real wood. *Id.* at 10:30-31.

106. I understand that Rassi is a U.S. patent that was filed on December 17, 2014, and issued on December 27, 2016. It has been explained to me Rassi is

considered prior art since it is an issued patent whose application was filed prior to August 24, 2015—the earliest priority date of the '350 patent.

VIII. Ground 1: Claims 1-4, 6, 9-12, 15, 17, 19-22, and 24 Are Obvious Over Nam in View of StaMixCo

A. Independent Claims 1, 10, 20, and 24

1. *Elements [1pre], [10pre], [20pre], [24pre], and [24a]*²

107. Nam explicitly discloses producing “synthetic wood having striped grain” that can be “introduced to a mold” in order to create three-dimensional synthetic wood that has “striped grain on both the surface and interior.” *See* RPI1011 at [0001]. Nam further discloses that this “synthetic wood” is made from “plastic,” “resin,” or “petrochemical” materials, which a person of ordinary skill in the art would have understood to be referring to “polymers.” *Id.* at [0004-05], [0007], [0018]. Nam additionally discloses that extruded synthetic wood products (like

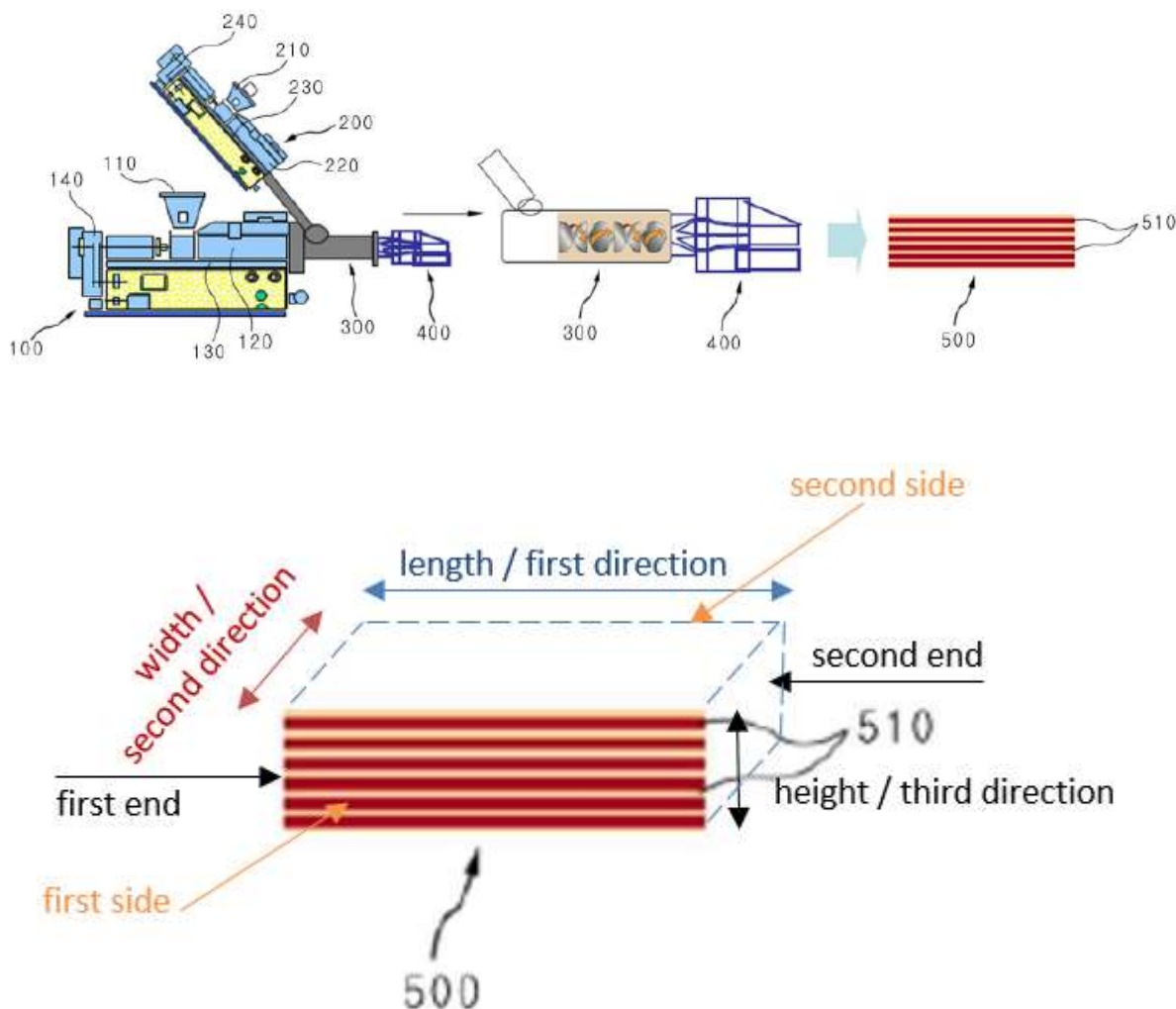
² I have not been asked to opine, and offer no opinion, as to whether the preambles of the Challenged Claims are limiting. For the purposes of this Petition, I have been asked to assume that they are limiting, and I therefore analyze their elements in the prior art. Also, I have grouped and analyze similar claim elements together, addressing any differences between them.

Nam's disclosed product) "are similar to wood materials, slabs, and lumber" and "are mainly used in building materials." RPI1011 at [0006].

108. It is therefore my opinion that a person of ordinary skill in the art would have understood that the polymeric wood disclosed by Nam, which has "striped grain on both the surface and *interior*," and is similar to "lumber" and other "building materials," is three-dimensional. RPI1011 at [0017] ("Fig. 3 is a *frontal* schematic diagram..."). In fact, it is specifically disclosed as being intended to be an improvement on the three-dimensional synthetic wood shown in Figure 1. RPI1011 at Fig. 1, [0004], [0010]. It is therefore my opinion that Nam discloses "[a] *simulated natural wood-grained polymer board*" ([1pre], [24pre]) or "*substrate*" ([10pre], [20pre]). A person of ordinary skill would have also understood that the extruded three-dimensional synthetic wood of Nam has a non-hollow "*core*" ([10pre]) and, because Nam discloses that its wood is made from polymers, that the core is a "*polymer core*" ([24a]). A person of ordinary skill in the art would have understood this, for example, by looking at Figures 2 and 3, which illustrate alternating polymeric layers extending along the entire cross-section and throughout the entire core of Nam's synthetic wood, and based on its description of the striped graining existing both on the surface and on the interior.

109. Any difference between the claimed “boards” and “substrates” would at most be one of dimensions. Both of these terms are described dimensionally in the claims as having a first, second, and third (or length, width, and height) dimension, as having a core, and as having sides and ends spaced apart from each other, with the ends defining the length or third direction. RPI1001 at Claims 1, 10, 17, 19, 20, 24. The specification states that the boards can be formed from the substrates, for example by cutting the substrates, and describes the boards as being “elongated.” RPI1001 at Abstract; 3:40-43; 6:63-7:2; 8:9-11. It is my opinion that a person of ordinary skill in the art would have known how to alter the dimensions of the wood disclosed in Nam, by choosing different dies and/or by applying various known post-processing steps, as Nam suggests (RPI1011 at [0015], [0020], [0026-0027]), such as cutting the extrudate into variously shaped and dimensioned “substrates” or “boards,” depending on the application for which they were intended to be used (*see also supra*, ¶¶ 29, 35).

110. It is also my opinion that Nam discloses each of the dimensional requirements of the claimed simulated wood set forth in **[1pre]**, **[10pre]**, **[20pre]**, and **[24a]**, as can be seen with reference to Figure 3 below:



RPI1011 at [0001], FIG. 3 (annotated).

111. As can be seen above, the simulated natural wood-grained polymer board of Nam ([1pre]), including its polymer core ([24a]) has a “*first side and a second side spaced apart from the first side, [the ([1pre])] spacing between the first and second sides defining ... a width ... of the*” board or core, “*the first and second sides extending along a length direction [of the core ([24a])] between a first end and*

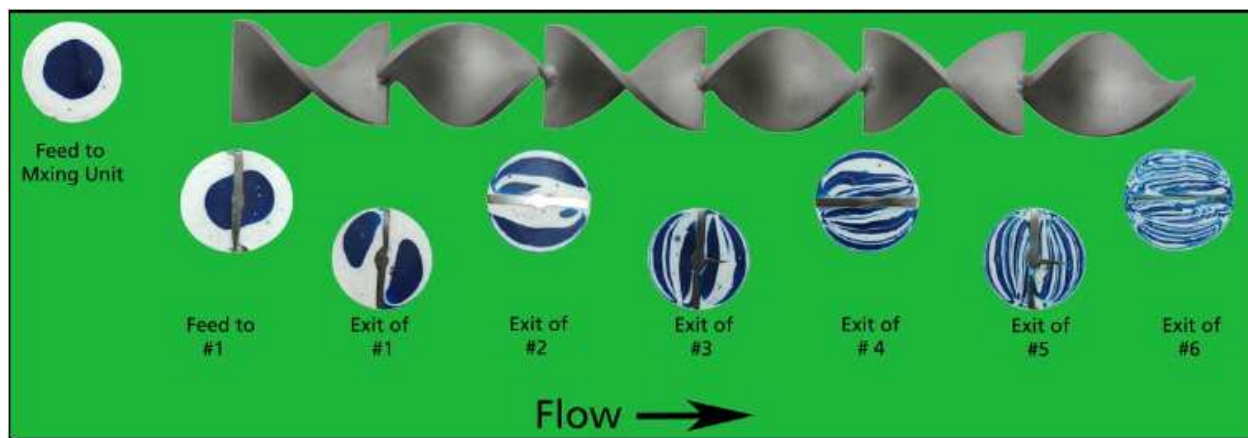
a second end, the first and second ends defining a length of the” board or core. Similarly, the simulated natural wood-grained polymer substrate of Nam “extend[s] along a first direction, the substrate having a first side and a second side spaced apart from the first side along a second direction different than the first direction, the first and second sides defining a width of the substrate, the first and second sides extending along the first direction, a core of the substrate extending between the first and second sides and along the first direction” ([10pre]) and has “a length defined along a first direction, a width defined along a second direction perpendicular to the first direction, and a height defined along a third direction perpendicular to both the first and second directions” ([20pre]). It is my opinion that each of these dimensions and spatial relationships is reflective of nothing more than those of a three-dimensional rectangular board or substrate. As I explained above, the core is the interior of Nam’s synthetic wood, which is non-hollow and is made up of the polymeric layers extending along the entire width, along the entire length, and alternating along the height direction.

112. Should PO argue that Nam does not explicitly disclose a simulated “natural wood-grained” look, despite Nam expressly disclosing “synthetic wood having striped grain” and its stated goal of “realiz[ing] the naturalness of real wood,”

Nam at [0010], it is my opinion that this element would have nevertheless been obvious in view of StaMixCo.

113. StaMixCo discloses “static mixer designs” that can be used in the extrusion of “molten polymer.” RPI1010 at 2. StaMixCo specifically discloses a helical static mixer in which two differently colored “viscous resin[s]” are pumped through six static mixing elements, with “cross-sectional cuts ... made at the outlet of each mixing element” to show the mixing of those resins following each element.

Id. at 10. This is illustrated in Figure 20:



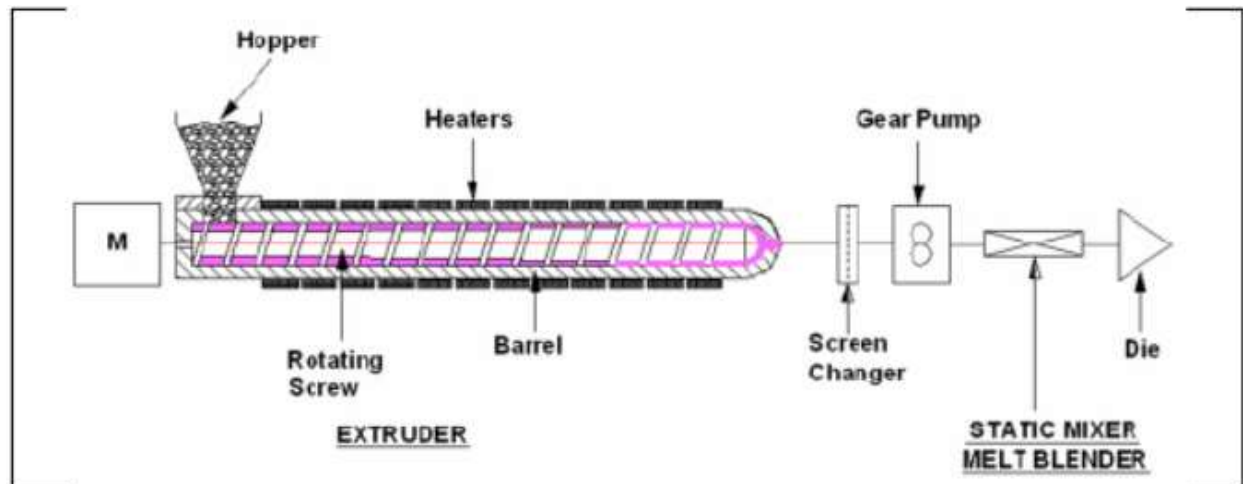
Id. at Fig. 20. StaMixCo further teaches that the static mixer is “installed just in front of the extruder die.” *Id.* at 2. It is my opinion that a person of ordinary skill would have understood that once the polymer melt exits the static mixer, no further mixing will occur and thus the pattern shown in the cross-section exiting a given static mixer element will be the pattern of the cross-section of the extruded product after it passes through a die.

114. The '350 patent admits as much. It concedes that the cross-section patterns shown in its Figures 5F and 5G—which are copied from StaMixCo's illustration of the cross-section patterns resulting at StaMixCo's "Exit of #5" and "Exit of #6"—will result in plastic lumber having a "*natural wood-grained*" appearance, as shown in Figs. 10 and 6 of the '350 patent, respectively, merely by being put through a die. RPI1001 at 3:52-54, 5:61-6:3, 6:24-61, 7:21-33.

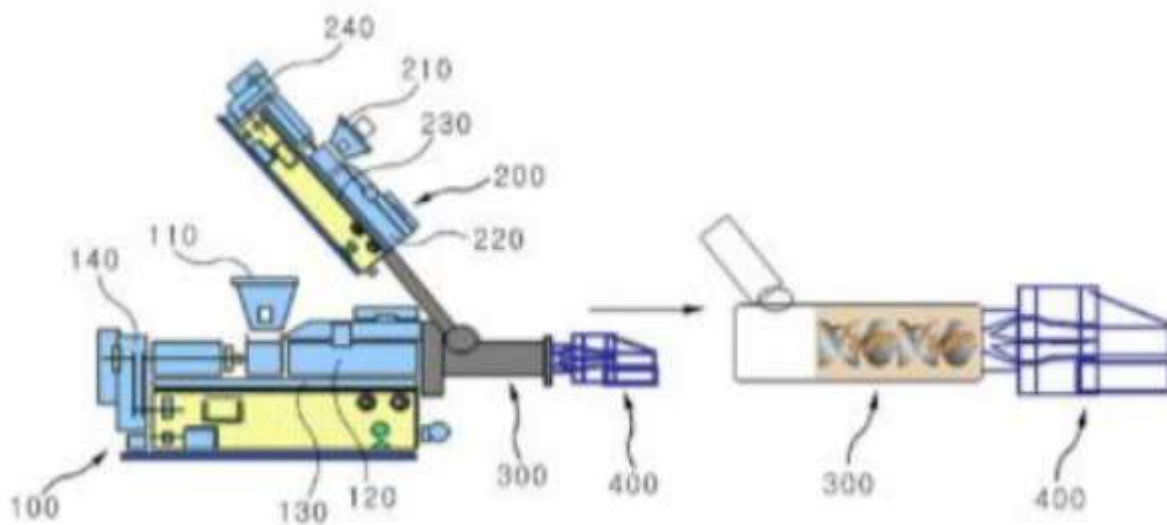
115. It is further my opinion that a skilled artisan would have been motivated to implement StaMixCo's static mixer in the extrusion apparatus of Nam. This combination would further Nam's goal of creating "synthetic wood having striped grain ... that can realize the naturalness of real wood." *Id.* at [0010]. Nam teaches that the striped pattern can be attained by preferably limiting the number of mixing elements so that "the mixture level of the mixture is considerably reduced." *Id.* at [0020]. StaMixCo similarly teaches that the mixer disclosed in its Figure 20 "is considered a low performance mixing device" that results in a "low degree of mixing." RPI1010 at 10. Nam shows the cross-section of the pattern created following each successive mixing element, with the graining pattern disclosed at each step, and in the final product in Nam being more rigid, less curved, and with less graining than the pattern disclosed in StaMixCo. *See* RPI1011 at FIG. 2. StaMixCo teaches that its mixer can achieve a more curved, and less rigid graining

pattern with more graining than the static mixer disclosed in Nam, and displays a cross-section of the pattern created following each successive mixing element. *See* RPI1010 at Fig. 20. A person of ordinary skill in the art would have therefore been motivated to use the static mixer disclosed in StaMixCo in the system disclosed in Nam in order to create “synthetic wood having striped grain” that can even better “realize the naturalness of real wood.” RPI1011 at [0010].

116. It is also my opinion that a person of ordinary skill in the art would have had a reasonable expectation of success in doing so due to the compatibility of the disclosures. As I discussed above, Nam teaches an extrusion system and process in which differently colored polymer melts are introduced from two separate extruders, are then pushed through a static mixer having helical mixing elements to impart a pattern, and are then shaped using a “die or mold” into synthetic wood. RPI1011 at [0011-14], [0018], [0022], [0024], [0026-28]. StaMixCo similarly discloses using differently colored polymer melts, to be pushed through a static mixer having helical mixing elements to impart a pattern, and then to be shaped into the final product using a die. RPI1010 at 2, 10, Fig. 20 (“Blue and white viscous resin ... is pumped through” the static mixer elements). The similar extruder—static mixer—die architecture of both disclosures can be seen from their respective disclosures:



(RPI1010 at Fig. 1)

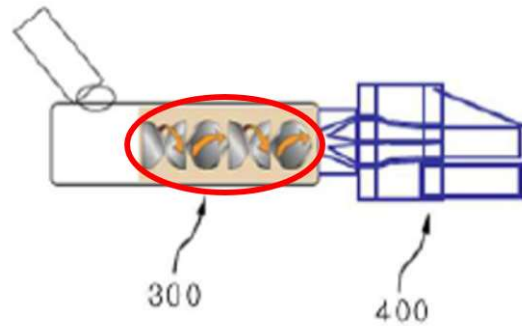


(RPI1011 at FIG. 3)

117. The helical mixing elements disclosed in Nam and StaMixCo are also similar:



RPI1010 at Fig. 20



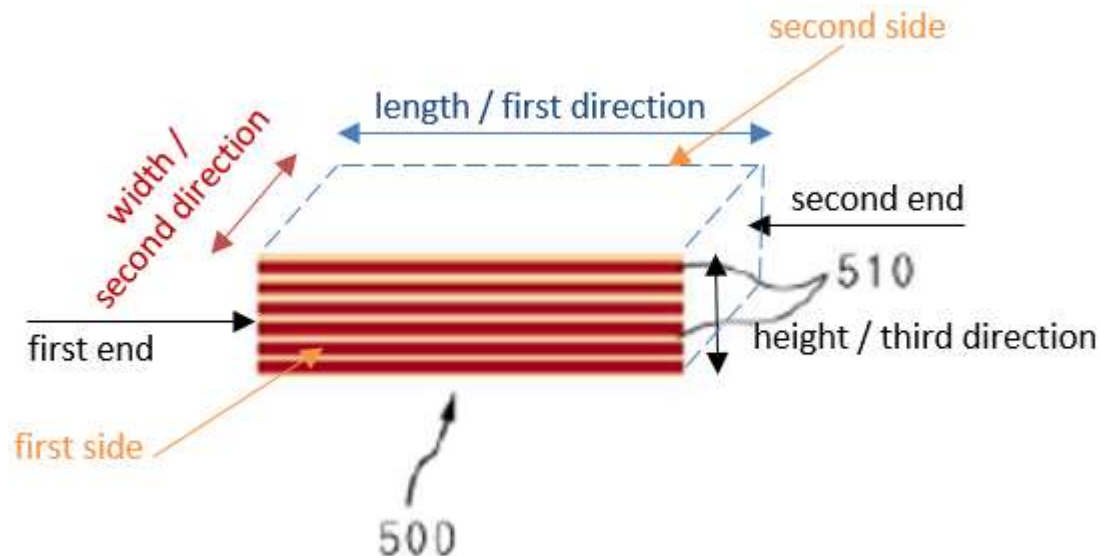
RPI1011 at FIG. 3 (annotated)

118. It is therefore my opinion that a person of ordinary skill would have readily been able to implement StaMixCo’s static mixer into the extrusion system of Nam, in order to arrive at polymer boards and substrates having a simulated, more “natural wood-grained” look. The selection of colors would have been a mere design choice to try to replicate the color of natural wood. Indeed, “pigmented polymer resins...intended specifically to impart wood appearance” were available from colorant manufacturers. RPI1012 at 413.

2. *Elements [1a] and [1b], [10a] and [10b], [20a] and [20b], [24b] and [24c]:*

119. Nam discloses that its synthetic wood is “configured such that it has striped grain on both the surface and interior of a two-color, heterogeneous mixture.” RPI1011 at [0001], [0020], [0027]. Nam creates this mixture by adding a polymer of one color through a “main extruder,” and a polymer of a second color through a “sub extruder,” into a heating cylinder with a static mixer. *Id.* at Abstract, [0011-12],

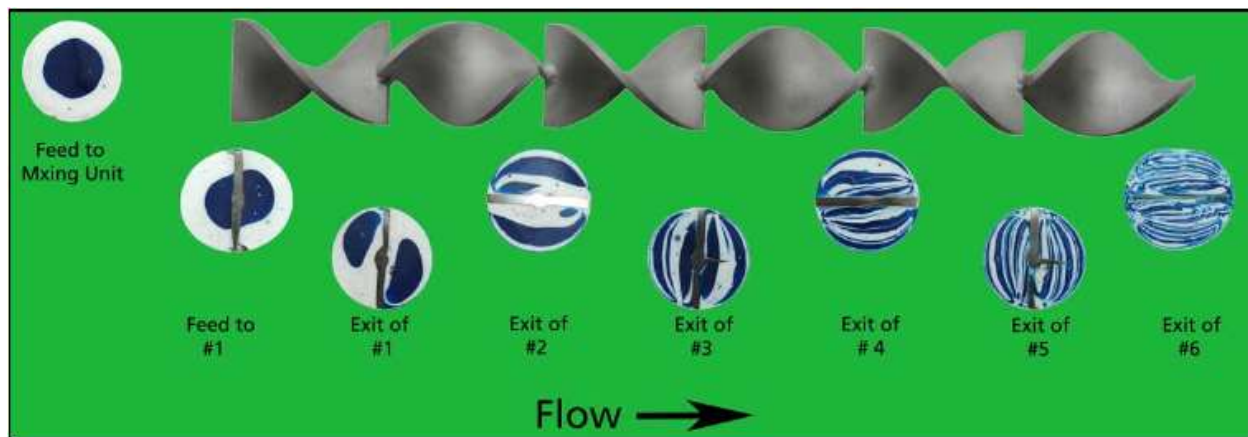
[0014-15], [0021-24]. Figure 3 illustrates the resulting striped pattern extending along the length of the entire board or substrate:



Id. at FIG. 3 (annotated). A person of ordinary skill would have understood that Nam’s synthetic wood is produced after the polymers exit the static mixer, after which point they are no longer being mixed and their pattern is no longer changing. Thus, a skilled artisan would have understood that this alternating-colored polymer structure will remain consistent along the entire “length” or “first direction” in the extrusion direction of whatever shape is defined by the die or mold that forms it. *See id.* at [0027].

120. This would also be the case if Nam were combined with StaMixCo in the way and for the reasons I discussed above. Like Nam, StaMixCo also teaches pushing two-differently colored polymers through a static mixer. RPI1010 at 5

(describing mixing of “blue and white viscous resins”), 6, 8, 10. A person of ordinary skill would understand that the pattern that exits the static mixer of StaMixCo, whether at “Exit of #5” or “Exit of #6” (depending on the number of elements used), would likewise remain fixed at that point (with no further mixing taking place) and remain consistent along the length in the extrusion direction of the wood formed after passing through the die or mold of the combined Nam and StaMixCo system. RPI1001, 3:52-54, 5:61-6:3, 6:24-61, 7:23-33.



RPI1010 at Fig. 20.

121. It is therefore my opinion that, as can be seen in Figure 3 above, the synthetic wood of Nam (and of its obvious combination with StaMixCo) comprises “a first set of polymer layers extending along the length direction and containing a first colorant, a majority of the first set of polymer layers extending along the [entire ([24b])] length of the [entire ([1a])]

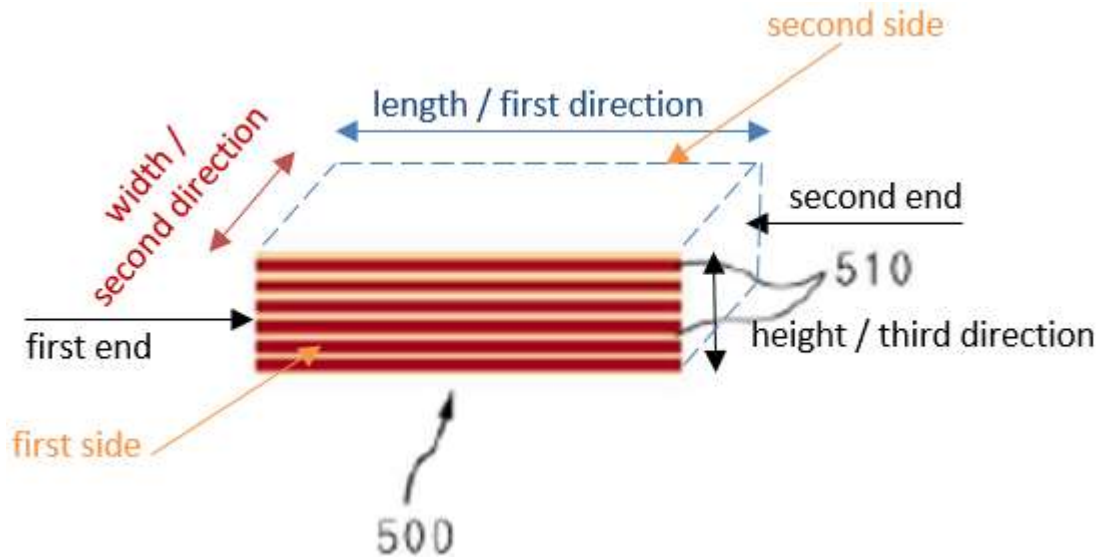
board ([1a]) or core ([24b]) (e.g., the lighter, orange color in Nam, the blue color in StaMixCo) and “a second set of polymer

layers extending along the length direction and containing a second colorant different than the first colorant, a majority of the second set of polymer layers extending along the [entire ([24c])] length of the [entire ([1b])]" board ([1b]) or core ([24c]) (e.g., the darker, red color in Nam, the white color in StaMixCo). It is therefore also my opinion that the substrates of **Claims 10** and **20** similarly comprise “a first set of polymer layers extending along the first direction and containing a first colorant, a majority of the first set of polymer layers being substantially continuous along the first direction” and “a second set of polymer layers extending along the first direction and containing a second colorant different than the first colorant, a majority of the second set of polymer layers being substantially continuous along the first direction.”

3. Elements [1c], [10c] and [10d], [20c] and [20d], and [24d]

122. Nam discloses that the “striped grain” pattern of its wood exists in “both the surface and interior” of the wood. RPI1011 at [0001]; [0020], [0027]. Because this pattern is consistent along the length of the wood that results from the extrusion process, it is my opinion that a person of ordinary skill in the art would have understood that the same pattern of alternating two-color layers that can be seen from the front of the wood shown in Figure 3 of Nam would also exist throughout its core. A person of ordinary skill in the art would have therefore understood that the wood shown in Figure 3 would have each of the lighter and darker polymer layers extend

along the entire width or second direction (from the first side to the second side), as illustrated in annotated Figure 3 below, with the lighter and darker colored layers alternating with one another along the height or third direction:



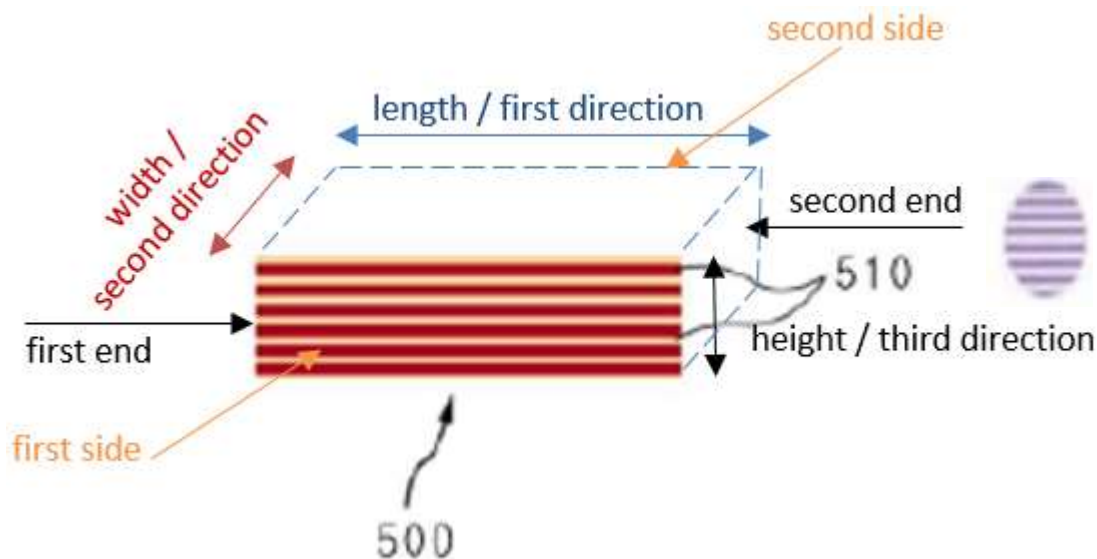
Id. at FIG. 3 (annotated).

123. My opinion is further confirmed by Nam's Figure 2, which shows a cross-section of the grain pattern inside the resulting wood based on the number of mixing elements used in the static mixer:

Number of elements	1	2	3	4	5
Partition figure					
Number of partitions	2	4	8	16	32

Id. at FIG. 2.

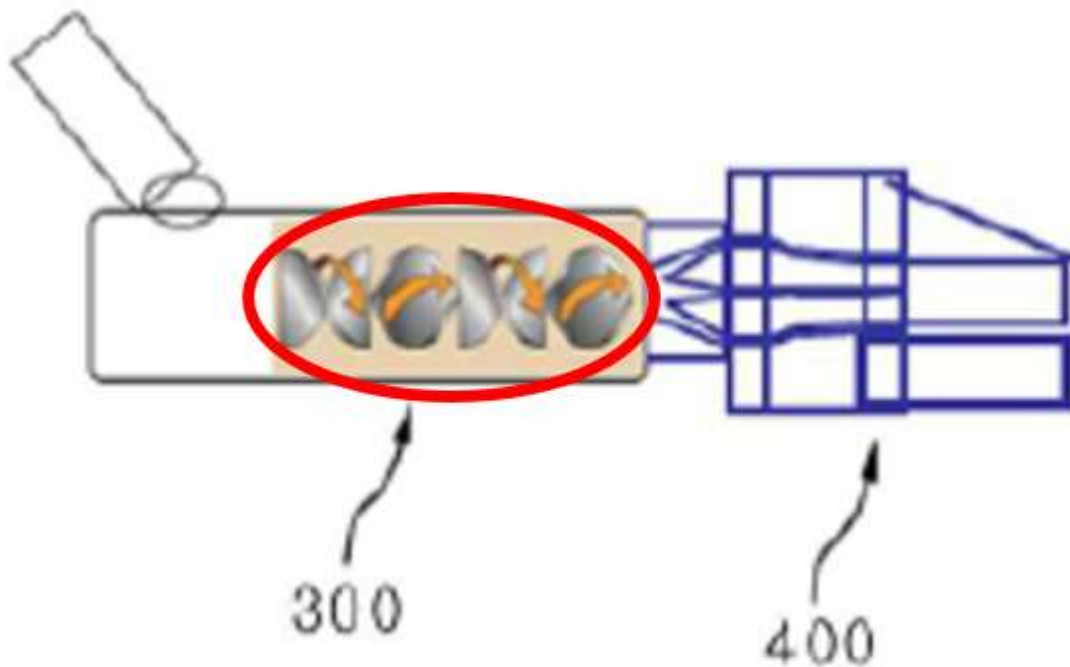
124. A person of ordinary skill would have understood that Figure 2 depicts the vertically-oriented grain pattern that would result inside the synthetic wood if the final mixing element were oriented vertically. As can be seen in Figure 2, each of those grains extends along the entire height of the cross-section (i.e., from top to bottom). Further, it is my opinion that a person of ordinary skill in the art would understand that the wood in Figure 3 would have a horizontally-oriented grain pattern throughout its core, consistent with the outside pattern in which the first and second sets of polymer layers alternate with one another, as described above. A horizontally-oriented cross section, resulting from the four mixing elements depicted in Nam, is shown side-by-side with the two-dimensional view of the board depicted in Figure 3, below, and shows that there are no interruptions of any kind in any of the polymer layers across the entire cross-section:



Id. at FIG. 3 (annotated); FIG. 2 (rotated).

125. Thus it is my opinion that, as can be seen in Figures 2 and 3, Nam discloses that “*a plurality of individual layers of the first and second sets of polymer layers alternate within the*” board ([1c]) or core ([24d]) “*and extend along a substantially uninterrupted ... path originating proximate the first side of the*” board ([1c]) or core ([24d]) “*and terminating proximate the second side of the*” board ([1c]) or core ([24d]). Similarly, it is my opinion that Nam discloses that the “*individual layers of the first and second sets of polymer layers alternate within the [core of the ([10c])] substrate [along the third direction ([20c])] to form a natural wood-grained appearance throughout the [core of the ([10c])] substrate*” and that “*a plurality of the individual layers of one of the [plurality of the ([20d])] first and second sets of polymer layers extend along a substantially uninterrupted ... path in the second direction originating proximate [the first side and terminating proximate the second side ([10d]) / an outer surface of a first portion of the substrate and terminating proximate an outer surface of a second portion of the substrate ([20d])].*” These alternating individual sets of polymer layers are what give the wood of Nam its “striped grain” appearance “on both the surface and interior” (RPI1011 at [0001]), and thus “*form a natural wood-grained appearance throughout the*” substrate or its core, as I explained earlier.

126. While Nam illustrates the patterns in the final synthetic wood board using straight lines, it is my opinion that a person of ordinary skill would have recognized that these illustrations are approximations. That is because Nam teaches that its patterns are created by using a “static mixer [that] repeats the arrangement of elements alternating in the form of a rectangular plate being twisted 180-degrees on the flow path of resin.” RPI1011 at [0018]. A person of ordinary skill in the art would have understood this to be describing a helical static mixer, which is also consistent with how Nam depicts its static mixer:



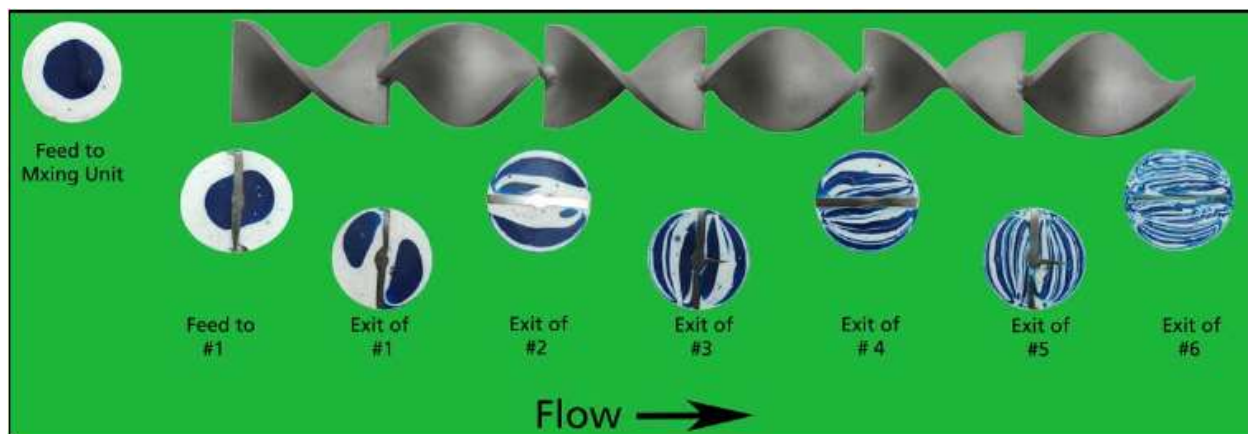
RPI1011 at FIG. 3 (annotated). A person of ordinary skill in the art would have known that a helical, static mixer creates curved layered patterns, as shown in

StaMixCo, for example. RPI1010 at Fig. 20. In fact, it was generally known in the art that a helical static mixer with a blade twist of 180° would create curved layered patterns. RPI1021 at 1337-38, Fig. 2; *see also id.* at 1335, Fig. 1(a) (“angle of blade twist 180° ”); RPI1023 at 297, Fig. 13. It is therefore also my opinion that Nam teaches that its polymer layers “extend along a substantially uninterrupted *curvilinear* path.”

127. Should PO argue that Nam does not disclose the alternating polymer layers forming a “*natural wood-grained appearance*” or not extending along a substantially uninterrupted “*curvilinear*” path, which it does for the reasons I have set forth, these elements would have nevertheless been obvious in view of StaMixCo. For the reasons I have discussed with respect to elements [1pre], [10pre], [20pre], [24pre], and [24a], it is my opinion that a person of ordinary skill in the art would have been motivated to combine the static mixer disclosed in StaMixCo with the extrusion apparatus disclosed in Nam, and had a reasonable expectation of success in doing so.

128. As I discussed with respect to those elements above, it is my opinion that a skilled artisan would have understood that once the polymer melt exits the static mixer and enters into the profile die, no further mixing will occur and thus the pattern shown in the cross-section exiting a given static mixer element will be the

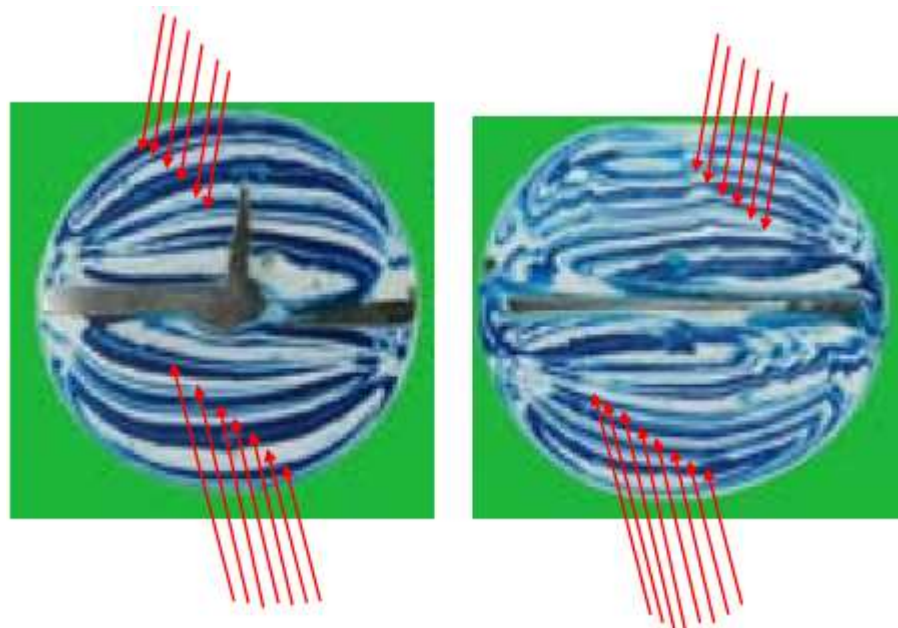
pattern of the cross-section of the extruded product. Thus, as the '350 patent itself admits, the cross-section patterns illustrated at “Exit of #5” and “Exit of #6”—reproduced as Figs. 5F and 5G in the '350 patent—once they were put through a die, would result in plastic lumber in which the “*alternating*” polymer layers form a “*natural wood-grained appearance throughout [the core of] the substrate*” and a plurality of them extend along the claimed “*substantially uninterrupted curvilinear path,*” “*terminat[ing]*” and “*originat[ing]*” “*proximate*” the sides of the board/substrate/or its core, or the substrate’s outer surfaces, as shown in Figs. 10 and 6 of the '350 patent, respectively. RPI1001 at 5:61-6:3, 6:24-61, 7:21-33.



RPI1010 at Fig. 20.

129. Thus, using the static mixer disclosed in StaMixCo with either 5 or 6 mixing elements in the extrusion apparatus of Nam would result in synthetic wood meeting each of these limitations.

130. In fact, just by looking at the cross-section of the polymer melt exiting either at “Exit of #5” or at “Exit of #6” of StaMixCo, it is my opinion that a person of ordinary skill would have recognized that a plurality of differently colored polymer layers alternate with one another, and continue in curved paths having no interruptions, “*terminat[ing]*” and “*originat[ing]*” “*proximate*” the sides of the board/substrate/or its core, or the substrate’s outer surfaces. Such exemplary alternating layers are annotated below, though additional ones are apparent to the naked eye throughout:

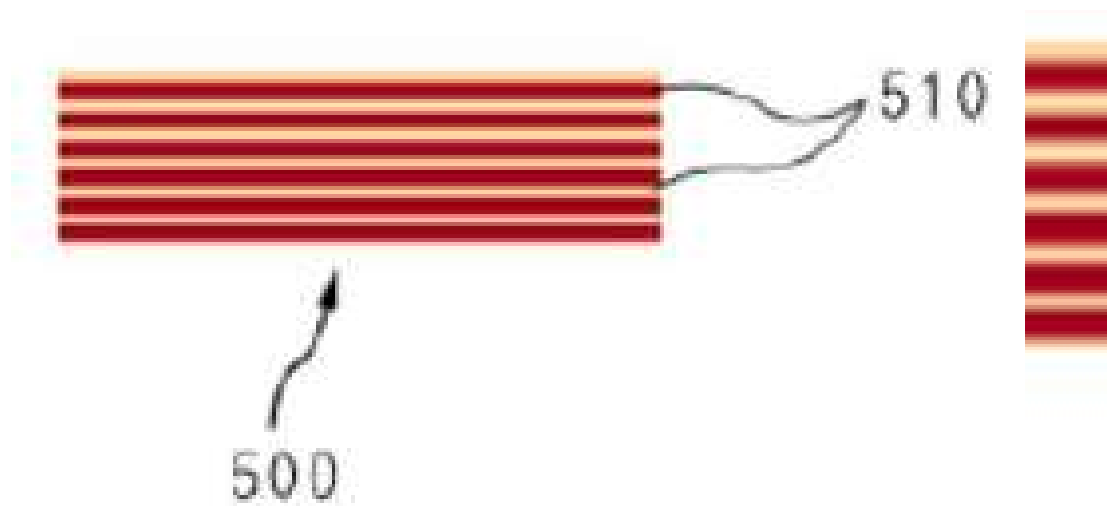


RPI1010 at Fig. 20, Exit of #5 (rotated and annotated), Exit of #6 (annotated). Should PO argue—notwithstanding the ’350 patent’s admission to the contrary—that there is not a plurality of these layers that “*terminate*” and “*originate*” “*proximate*” the sides of the board/substrate/or its core, or the substrate’s outer surfaces, this could

be easily accomplished by post-processing the substrates/boards, by cutting them (as was known) so that the grain patterns extend along the entire width, as is the case in Nam. *See supra*, ¶¶35, 122-125; RPI1011 at Figs. 2 and 3, [0015], [0020], [0026-0027].

B. Claims 2, 11, and 21

131. It is my opinion that, as can be seen in Figure 3 of Nam, its “*first set of polymer layers*” (e.g., the lighter, orange colored layers) “*are thinner than the layers of the second set of polymer layers*” (e.g., the darker, red colored layers):



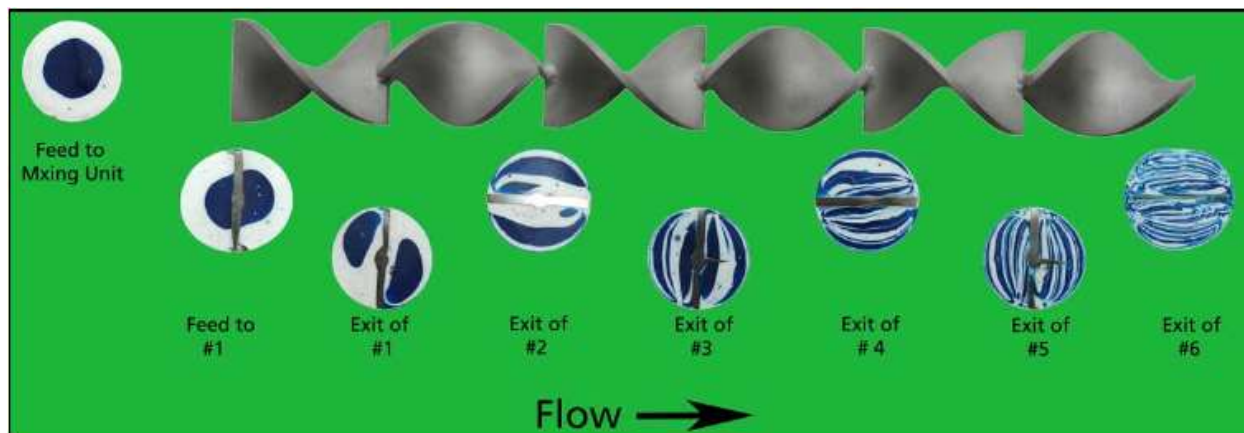
RPI1011 at FIG. 3 (magnified).

132. Nam discloses that separate polymers are introduced into the heating cylinder via a “main extruder” and a “sub extruder,” which a person of ordinary skill in the art would have understood to mean that more polymeric material would be introduced through the “main extruder” than the “sub extruder,” resulting in thinner

layers for the polymer introduced through the sub extruder. *See id.* at [0011], [0014], [0022-24].

133. Should PO argue that Nam does not explicitly disclose the first set of polymer layers being “*thinner*” than the second, it is my opinion that such an arrangement would have been obvious in view of StaMixCo. First, it is my opinion that a person of ordinary skill in the art would have been motivated to combine the static mixer disclosed in StaMixCo with the extrusion apparatus disclosed in Nam, and had a reasonable expectation of success in doing so, for the reasons I provided earlier with respect to elements [1pre], [10pre], [20pre], [24pre], and [24a].

134. As I discussed with respect to those elements above, it is my opinion that a person of ordinary skill in the art would have understood that once the polymer melt exits the static mixer, no further mixing will occur and thus the pattern shown in the cross-section exiting a given static mixer element will be the pattern of the cross-section of the extruded product. Thus, by the '350 patent's own admission, the cross-section patterns illustrated at “Exit of #5” and “Exit of #6”—reproduced as Figs. 5F and 5G in the '350 patent—would result in plastic lumber in which the first set of polymer layer is “*thinner*” than the second set once they were put through a die, as shown in Figs. 10 and 6 of the '350 patent, respectively. RPI1001 at 5:61-6:3, 6:24-61, 7:21-33.



RPI1010 at Fig. 20.

135. Thus, using the static mixer disclosed in StaMixCo in the extrusion apparatus of Nam would result in synthetic wood meeting these limitations.

136. Furthermore, it is my opinion that having one set of polymer layers be “*thinner*” than the other set would have been nothing but an obvious design choice. The goal of Nam, as noted above, was to create synthetic wood “having striped grain” that could better “realize the naturalness of real wood.” RPI1011 at [0010]. It is therefore my opinion that a skilled artisan would have been motivated to experiment with the thickness of the graining to better achieve this goal, especially depending on the type of wood the skilled artisan was attempting to simulate.

137. It is also my opinion that a person of ordinary skill in the art would have had a reasonable expectation of success. Nam teaches that “when one of the[] elements [of its static mixer] is passed through, it doubles the number of layers.” *Id.* [0018]. StaMixCo discloses a similar effect resulting from its static mixer in Figure

20. RPI1010 at Fig. 20. It is my opinion that a person of ordinary skill would have therefore been able and known to control the relative thickness of the polymer layers by introducing the two differently-colored polymers in different amounts into the static mixer (of either Nam or StaMixCo). This would result in the polymer being introduced in a lesser amount being divided into layers that are “thinner” than those of the polymer introduced in a greater amount as they passed through each mixing element.

C. Claim 3

138. As I discussed above, Nam discloses that its striped grain synthetic wood can go through “follow-up processes such as ... cutting.” RPI1011 at [0027]. Nam further discloses that its synthetic wood has “striped grain on not only the surface, but also on the inside.” RPI1011 at [0020]. As I further explained above, this graining extends from one side of the board to the other, as well as along its entire length direction (and would continue to do so if Nam were combined with StaMixCo in the manner and for the reasons discussed above). *Supra*, ¶¶119-25. The polymer layers also follow a curved pattern from side to side and alternate with one another, as I explained. *Supra*, ¶¶122-30.

139. Thus, it is my opinion that a person of ordinary skill would have understood that if the wood of Nam (or of its combination with StaMixCo) were cut so as to remove a portion of at least one of the first or second sides of the board, this

would expose portions of the first and second sets of polymer layers along the length direction. Indeed, Nam distinguishes its wood over other synthetic woods on which “only the surface has a striped grain,” whereas Nam’s wood striped grain is also obtained on the inside. RPI1011 at [0009], [0027]. It is also my opinion that a person of ordinary skill would have understood that removal of at least one of the first or second sides of the board may occur if the board were cut along (and parallel to) its length direction, or if it were planed. Both cutting and planing of plastic lumber was known and done before the alleged invention of the ’350 patent, and does not constitute an inventive aspect of the patent. RPI1001 at 1:31-37; *supra*, ¶35. These would have been ordinary, known post-processing steps intended to get the correct dimensions of the lumber and to smoothen it, respectively, for the application at hand. *Supra*, ¶35.

140. It is thus my opinion that Nam and its obvious combination with StaMixCo disclose Claim 3’s additional requirement of a board “*wherein a portion of at least one of the first side and second side of the board is removed to expose portions of the first and second sets of polymer layers along the length direction.*”

D. Claim 4

141. As I explained above, the ’350 patent discloses that a “burled grain” pattern is what necessarily results from planing the surface of a board that has internal graining formed from the claimed polymer layers, so long as those layers do

not terminate at a perpendicular angle to the surface. *Supra*, ¶¶85-90. It is therefore my opinion that a skilled artisan would have understood that planing the board of Nam or of its obvious combination with StaMixCo, each of which has curved grain patterns that do not run perpendicular to the surface, would result in a burled grain pattern being exposed, within the meaning of the '350 patent.

142. Indeed, by the '350 patent's own admission, the cross-section patterns illustrated at "Exit of #5" and "Exit of #6"—reproduced as Figs. 5F and 5G in the '350 patent of StaMixCo—would result in plastic lumber, once they were put through a die, in which *"the exposed portions of the first and second sets of polymer layers form a burled grain pattern."* That is, according to the '350 patent, the cross-section patterns illustrated at "Exit of #5" and "Exit of #6," once they were put through a die, would result in plastic lumber having the curvilinear graining as shown in Figs. 10 and 6 of the '350 patent, respectively. RPI1001 at 5:61-6:3, 6:24-61, 7:21-33. The '350 patent further teaches that "a thin layer can be removed from each outer surface 12" of the wood shown in Fig. 6," such as by planing, to expose the wood grain pattern 16 as suggested in FIG. 9," in which "a burling effect is created due to the horizontally oriented and closely spaced grains 16." RPI1001 at 6:38-43.

143. It is thus my opinion that Nam and its obvious combination with StaMixCo disclose Claim 4's additional requirement of a board "*wherein the exposed portions of the first and second sets of polymer layers form a burled grain pattern resulting from planing the surface.*"

E. Claims 6, 12, and 22

144. As I discussed above, StaMixCo teaches that its static mixer can be used to extrude polymers and Nam discloses creating synthetic wood by using a static mixer to extrude polymers. A person of ordinary skill in the art would have found it obvious to use HDPE as the specific polymer to be extruded in the Nam system, or in its obvious combination with the static mixer of StaMixCo.

145. HDPE was one of the most commonly used types of polymers in simulated wood production prior to the '350 patent. RPI1018 at 1, 4, 10, 16; *supra*, ¶36. More than a dozen companies used HDPE to create polymer lumber at the time of the '350 patent. RPI1018 at 8, 16; *supra*, ¶36.

146. Indeed, a person of ordinary skill in the art would have known of several benefits for using HDPE in simulated wood production. *Supra*, ¶36. For example, HDPE was known to be cost effective and to be easy to work with due to its processing temperature range and rheology or melt strength behavior. RPI1029 at 2. It was also known that HDPE has good moisture barrier and chemical resistance properties, which makes it particularly useful in plastic lumber. RPI1029 at 24;

supra, ¶36. A person of ordinary skill in the art would have further known that HDPE boards have suitable strength for most applications that would use natural lumber. RPI1018 at 20.

147. Additionally, HDPE has significant environmental benefits for creating synthetic wood, because it does not require natural wood and can be made from recycled materials. RPI1018 at 16; *supra*, ¶36. It is also easier to recycle end-of-life HDPE boards than composite boards that contain materials such as other plastics, fiberglass, and/or wood fiber or wood flour. RPI1018 at 1, 3, 16. Compared to other plastics such as polystyrene (“PS”) and polyvinyl chloride (“PVC”), HDPE boards contain fewer chemical hazards and associated environmental impacts through their lifecycle of production, use, and disposal. RPI1018 at 4. This is because HDPE lacks the additional toxic inputs required to make PS and PVC. RPI1018 at 10.

148. For these reasons, it is my opinion that a person of ordinary skill would have considered HDPE to be a common and preferable polymer to use in the simulated wood board created by Nam or its obvious combination with StaMixCo. It is further my opinion that such a skilled artisan would have also had a reasonable expectation of success in using HDPE in creating plastic lumber, as evidenced by the fact that several companies had previously done so, the ’350 patent does not suggest any inventiveness or specialized knowledge required in using it, and

extruding HDPE to create plastic lumber was well-known in the art at the time of the '350 patent. *See* RPI1018 at 1, 4, 8, 10, 16; RPI1029 at 28; RPI1012 at 407-08, 412-13; RPI1030 at 104-08; *see also supra*, ¶¶27-29, 36.

149. Therefore, it is my opinion that it would have been obvious to “*form[]*” “*the first and second sets of polymer layers*” of the wood disclosed by Nam and by its obvious combination with StaMixCo “*from high density polyethylene*.”

F. Claims 9 and 15

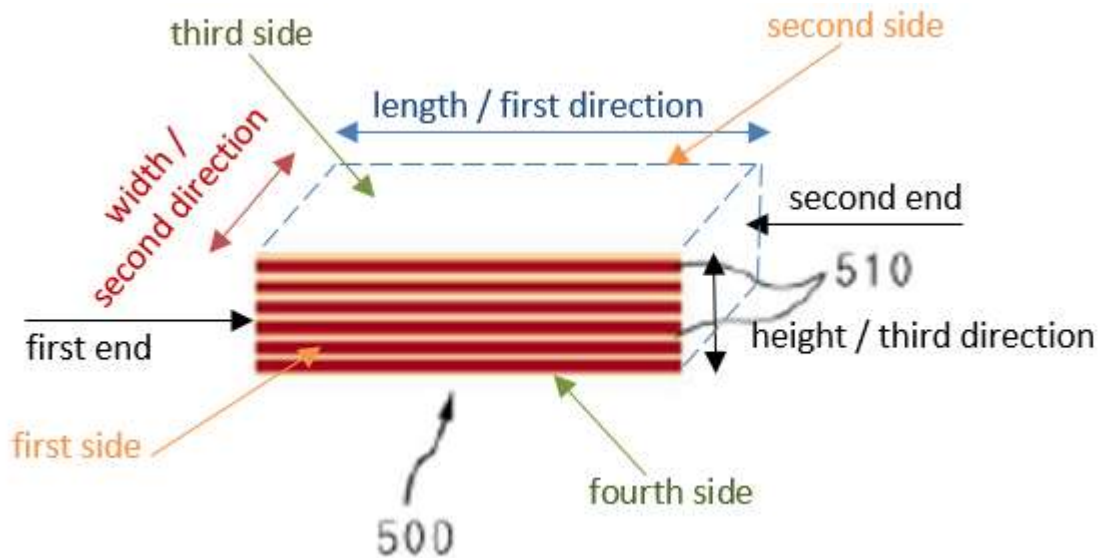
150. As I discussed with respect to the independent claims, Nam discloses a three-dimensional synthetic wood board or substrate. *Supra*, ¶¶107-08. It further discloses that extruded synthetic wood products are “mainly employed in building materials” and are “similar to wood materials, slabs, and lumber.” RPI1011 at [0004], [0006]. In Figure 3, Nam provides a “frontal” view of what a person of ordinary skill in the art would have understood to be a three-dimensional, rectangular synthetic wood product. *Id.* at FIG. 3. It is my opinion that a person of ordinary skill in the art would have therefore understood that the synthetic wood boards and substrates disclosed in Nam can, at a minimum, have a rectangular cross-section along their length. StaMixCo also discloses extrusions having rectangular cross-sections along their length. RPI1010 at Figs. 3, 4. Both references also teach using a die following the exit of the static mixer, which a person of ordinary skill in the art would understand could be used to create products having the desired shape.

RPI1010 at 2 (the mixer “is installed just in front of the extruder die”); RPI1011 at [0027] (describing using a die); *see supra*, ¶¶109, 116.

151. Accordingly, it is my opinion that Nam and its obvious combination with StaMixCo disclose a board or substrate that “*is formed to define a polygonal cross-section along [its] length.*” It is my further opinion that it would have been obvious to give the board or substrate such a shape through post-processing or by using a die with the desired profile, for the reasons I discussed above, not least of which being to simulate the shape of a natural wood board and for the board to be used as lumber. *See supra*, ¶¶36, 107-11, 116; RPI1033 at 1 (defining plastic lumber as being “typically used as a building material for purposes similar to those of traditional lumber, which is usually rectangular in cross-section”).

G. Claims 17 and 19

152. **Claims 17 and 19**, which depend from **Claims 1 and 10**, respectively, merely recite a third dimension to the claimed board and substrate. For largely the same reasons I discussed with respect to elements **[1pre]**, **[10pre]**, **[20pre]**, and **[24pre-24a]** above, and with reference to annotated Figure 3 below, it is my opinion that Nam and its obvious combination with StaMixCo discloses each of these additional dimensional limitations:



Id. at FIG. 3 (annotated).

153. Because the synthetic wood of Nam is rectangular and three-dimensional, as I discussed earlier, it will include a “height” or “third direction.” Thus, as can be seen in Figure 3 above, it is my opinion that the wood of Nam comprises “a third side and a fourth side spaced apart from the third side along a [height (Claim 17) / third (Claim 19)] direction different than the [length direction and width direction (Claim 17) / first and second directions (Claim 19)], wherein the third and fourth sides define a height of the [board (Claim 17) / substrate (Claim 19)], wherein the third and fourth sides extend along the [length (Claim 17) / first (Claim 19)] direction [between the first and second ends (Claim 17)].”

154. As I also previously discussed, the three-dimensional synthetic wood of Nam includes a “core” and the woodgrain pattern extends throughout the entire

core. *E.g., supra*, ¶¶ 108-111; 107-130. Thus, with reference to Figure 3 above, it is my opinion that Nam discloses that “*the core of the [board (Claim 17) / substrate (Claim 19)] extends between the first, second, third, and fourth sides [and between the first and second ends (Claim 17) / and along the first direction (Claim 19)], and wherein the individual layers of the first and second sets of polymer layers alternate within the core of the [board (Claim 17) / substrate (Claim 19)] along the [height (Claim 17) / third (Claim 19)] direction.*”

155. It is also my opinion that each of these limitations would continue to be met by Nam if it were combined with StaMixCo in the manner and for the reasons I discussed earlier. *Supra*, ¶¶ 107-130. Simply from looking at Figure 20 of StaMixCo, a person of ordinary skill would have recognized that in order for the individual layers to “*alternate within the core ... along the [height / third direction],*” the final mixing element of StaMixCo would simply need to be oriented in a horizontal manner and put through a die or mold, as I also described above. RPI1010 at Fig. 20. Thus, it is my opinion that each of these additional limitations would have been disclosed by Nam and by its obvious combination with StaMixCo.

IX. Ground 2: Claims 5, 7-8, 13-14, 16, 18, and 23 Are Obvious Over Nam in View of StaMixCo, and Further in View of Rassi

A. Claim 5

156. Rassi provides an example in the prior art of extruded plastic lumber having embossed surfaces. RPI1013 at 1:32-38 (background prior art); 3:20-22; 6:6-10. Rassi, like Nam, teaches plastic lumber created through an extrusion process. *Id.* at Abstract, 1:10-62, 1:66-2:20. Rassi, like Nam, is also concerned with creating plastic lumber that is “aesthetically pleasing, exhibiting a ‘natural’ look like the look of grains in wood boards.” RPI1013 at 5:63-65; 1:57-58. Rassi is also similarly concerned with creating plastic lumber in which “the graining pattern extends into the core of the board,” and is not limited to its surface. RPI1013 at 1:25-62, 10:31-33.

157. Rassi further teaches that the look and feel of any outer surface of such simulated wood boards can be “augmented by *embossed grain-like patterns*” to further imitate natural wood. RPI1013 at 6:6-10 (emphasis added); *see also id.* at 3:20-22 (“In one or more embodiments, a method of forming an extruded board includes *embossing* the outer exposed portion of the board.”). Indeed, Rassi repeatedly discusses using embossing to further “mimic[] the look of real wood” and to provide a “grain-like texture.” RPI1013 at 1:32-33, 1:48-50, 3:20-22, 6:6-10, 12:11-12.

158. It is my opinion that a person of ordinary skill would have therefore been motivated to emboss the surfaces of the wood created by Nam (or its obvious combination with StaMixCo), as taught by Rassi, in order to further Nam's goal of simulating "the naturalness of real wood." RPI1011 at Abstract, [0009-10]. It is also my opinion that a person of ordinary skill in the art would have been motivated to emboss the plastic lumber's surfaces for antislip reasons (i.e., to provide better traction on the surfaces of the plastic lumber, on which people might walk, including in wet, outdoor conditions). Slip resistance was a well-known consideration for plastic lumber prior to the '350 patent, to the extent that industry standards were being considered for establishing minimum slip resistance criteria. RPI1033 at 6, § 6.5 (also noting that as "with all decking materials, in some cases egress areas will require specific treatments in order to reduce the possibility of accidental slipping").

159. Because embossing plastic lumber was a known technique applied after the plastic lumber was extruded, it is my opinion that a person of ordinary skill in the art would have also had a reasonable expectation of success in applying this technique to the plastic lumber produced by Nam (or its obvious combination with StaMixCo). *See supra*, ¶35. My opinion is further confirmed by the '350 patent's generic statements that its plastic lumber products "can be post-processed" and "further enhanced by embossing techniques," without providing any further

information as to what those techniques might entail. *E.g.*, RPI1001 at 3:40-43, 6:34-38.

160. Accordingly, it is my opinion that it would have been obvious to “*emboss[] with a wood grain pattern*” “*at least one of the first and second sides of the board*” of Nam or of its obvious combination with StaMixCo, in view of Rassi.

B. Claims 7 and 13

161. As I discussed above, Rassi, like Nam, discloses plastic lumber created through an extrusion process that is intended to resemble the look of real wood both on its surface and inside. Rassi further teaches that its extruded polymers include various additives, such as “chemical *foaming agents (CFA’s)*, ... and *UV stabilizers*.” RPI1013 at 6:40-42. Rassi particularly emphasizes that its polymeric resins include chemical foaming agents. *Id.* at 2:47-51. Rassi also makes clear that its polymer resins each include a color additive, which in turn “typically includes UV stabilizers.” *Id.* at 2:52-59; 7:1-4.

162. With respect to the foaming agents, Rassi teaches that they are utilized to form “void spaces,” which can “provide texture to the outer surface” of the plastic lumber that makes them “closer to the feel of real wood” and that also “permit the board ... to retain stains.” *Id.* at 5:67-6:12. It is also my opinion that a person of ordinary skill would have understood that foaming agents will affect the density of an object. RPI1031 at 17; RPI1022 at 5:20-35, 10:49-11:5, 14:24-32; *supra*, ¶37. To

that end, Rassi teaches that the “[d]ensity” of its plastic lumber “is varied to achieve a desired mechanical performance (i.e.: flexural strength, screw retention, brittleness etc.).” RPI1013 at 6:40-46.

163. It is therefore my opinion that a person of ordinary skill would have been motivated to add foaming agents, as taught by Rassi, into the polymer layers of the wood boards produced by Nam (or its obvious combination with StaMixCo). Doing so would have furthered Nam’s goal of simulating “the naturalness of real wood.” RPI1011 at Abstract, [0009-10]. Specifically, using foaming agents would “provide texture to the outer surface” of the plastic lumber that is “closer to the feel of real wood” and permit it to be stained. RPI1013 at 5:67-6:12. It is also my opinion that a person of ordinary skill would have understood that foaming agents can reduce the weight of polymer boards, thus reducing transportation costs and the weight of any end products, and reduce their material costs, providing additional motivation to implement them. *See* RPI1031 at 17; RPI1022 at 5:20-35, 10:49-11:5, 14:24-32; RPI1011 at [0007] (discussing the need to reduce the cost of synthetic wood); *supra*, ¶37. Furthermore, StaMixCo expressly contemplates “additives” being used in its polymer melts. RPI1010 at 2, 4, 11.

164. With regard to UV inhibitors, it is my opinion that a person of ordinary skill would have known that they could be used to prevent color and structural

degradation from constant exposure to sunlight. RPI1013 at 6:40-42; RPI1032 at [0015]; RPI1029 at vii; RPI1016 at 143; *supra*, ¶37. In other words, UV inhibitors help increase the aesthetic longevity and the durability of simulated wood boards. It is therefore my opinion that a person of ordinary skill would have been motivated to add UV inhibitors, as taught by Rassi, into the polymer layers of the wood boards produced by Nam (or its obvious combination with StaMixCo) for these very purposes. This is especially true in view of Nam’s stated goal of having plastic wood with a natural wood-grain appearance, which the UV inhibitors would help prevent from deteriorating, and Nam’s stated intention for its plastic wood to be used as “lumber” and in “building materials,” which could be expected to be used outdoors. *See* RPI1011 at Abstract, [0008-10] (seeking to create a synthetic board with a natural wood-grained appearance); [0004-06] (discussing use in building materials and lumber); RPI1018 at 19; *supra*, ¶37; RPI1033 at 1 (defining plastic lumber as being “typically used as a building material for purposes similar to those of traditional lumber”). And, again, StaMixCo expressly contemplates “additives” being used in its polymer melts. RPI1010 at 2, 4, 11.

165. Because adding UV inhibitors and foaming agents into the polymeric layers of plastic lumber during the extrusion process was a known process, it is my opinion that a person of ordinary skill would have also had a reasonable expectation

of success in including these additives in the polymer layers of the plastic lumber produced by Nam (or its obvious combination with StaMixCo). *Supra*, ¶37. My opinion is further confirmed by the '350 patent's generic statements that the polymer layers of its plastic lumber products "can include" or be "mixed with other additives, such as UV inhibitors, foaming agents," without providing any further information as to how that is done. *E.g.*, RPI1001 at 3:35-39, 4:8-18. Rassi similarly refers to "using a foaming agent" in plastic lumber "*as is generally known in the art.*" RPI1013 at 5:66-6:1.

166. Accordingly, it is my opinion that a person of ordinary skill in the art would have found it obvious to "*include at least one of a UV inhibitor and a foaming agent*" in "*the first and second sets of polymer layers*" of the wood of Nam (or of its obvious combination with StaMixCo), in view of Rassi.

C. Claims 8 and 14

167. For the reasons discussed with respect to Claims 7 and 13, it is my opinion that a person of ordinary skill in the art would have found it obvious to "*include[]a foaming agent*" in "*one of the first and second sets of polymer layers*" of the board of Nam (or of its obvious combination with StaMixCo), in view of Rassi.

D. Claims 16, 18, and 23

168. Nam does not disclose using any natural wood materials in its synthetic wood. On the contrary, Nam faults prior art “conventional synthetic wood panel[s]” which use plastic “mixed with wood shavings (shavings, sawdust).” RPI1011 at [0004]. As Nam explains, natural wood has short comings as compared to plastic wood, which is “less absorbent than natural wood and does not rot.” *Id.* at [0006]. Nam further references the “issue of environmental conservation ha[ving] become prominent worldwide.” *Id.* at [0002]. Nam also explains that the prior art only had “an external appearance and properties similar to that of natural wood,” which resulted from “firing when molding plastic mixed with wood shaving (shavings, sawdust) and a blowing agent.” *Id.* at [0004], [0009]. The wood fragments used in the prior art were “inserted during molding.” *Id.* at [0005].

169. Nam goes on to state that its “invention was devised by considering the problems with the above-described prior art.” *Id.* at [0010]. Based on my analysis of Nam, nowhere in the disclosure of its invention does Nam describe using natural wood materials to create its synthetic wood, nor adding them during the molding process. Instead, Nam discloses a different method of introducing wood graining to both the surface and the core of its synthetic wood board, that does not require the use of any natural wood materials and therefore overcomes the shortcomings of products that utilize such materials. It is my opinion that a person of ordinary skill

in the art would have therefore understood that the synthetic wood disclosed in Nam has a “*core [that] is substantially free of natural wood materials.*” Combining Nam with the static mixer of StaMixCo would not change this determination either, as StaMixCo does not suggest the use of natural wood materials and instead expressly teaches that its static mixers can be used for the extrusion of “viscous polymers,” “molten polymers,” and “resins,” which is how Nam uses a static mixer. RPI1010 at 1, 2, 10.

170. Should PO argue that Nam or its obvious combination with StaMixCo does not explicitly disclose having “*the core [be] substantially free of natural wood materials,*” it is my opinion that this limitation would have nevertheless been obvious in view of Rassi. Rassi, like Nam, recounts various shortcomings with using natural wood, including its “susceptib[ility] to various pests and decay” and to “deteriorate over time.” RPI1013 at 1:10-15. Rassi, like Nam, also discusses prior art products in which “wood is mixed with a resin in order to extrude an artificial board” but faults it for having the same “major shortcoming” identified in Nam, which is that the resulting board fails to look like a natural wood board. *Id.* at 1:25-31. Rassi likewise expresses a concern regarding the depletion of wood resources worldwide. *Id.* at 1:16-18. Rassi expressly teaches that its synthetic wood is therefore made solely from synthetic materials such as polymers, foaming agents, color

concentrates, and UV stabilizers. RPI1013 at 6:36-46. Thus, Rassi teaches that simulated wood boards can be created without any natural wood materials.

171. It is further my opinion that a person of ordinary skill in the art would have been motivated to remove substantially all such natural wood materials from the core of the synthetic lumber made by Nam (and its obvious combination with StaMixCo) due to the shortcomings expressed with natural wood in both Nam and Rassi. RPI1011 at [0002-4], [0007]; RPI1013 at 1:10-24. It is my opinion that a person of ordinary skill would have been further motivated to do so by Nam's and Rassi's expressed environmental conservation concerns. RPI1011 at [0002]; RPI1013 at 1:16-18. Consistent with those concerns, I believe that a person of ordinary skill would have also known that plastic boards containing natural wood materials are harder to recycle than purely polymer boards, and are thus more detrimental to the environment. RPI1018 at 1, 3, 16; *supra*, ¶¶ 27. 147.

172. Because having plastic lumber substantially free of any natural wood materials in their core was known, it is my opinion that a person of ordinary skill in the art would have had a reasonable expectation of success excluding substantially all such natural wood materials from the plastic lumber produced by Nam (or its obvious combination with StaMixCo). *Supra*, ¶¶ 25, 27. Indeed, Nam does not suggest that natural wood materials are in any way required in its synthetic wood.

My opinion is further confirmed by the '350 patent's generic statement that the polymer substrate claimed "can be free of natural wood or other organic fibers," without any further explanation. *E.g.*, RPI1001 at 3:33-35.

X. Ground 3: Claims 1-4, 6, 9-12, and 15-24 Are Obvious Over Zumbrunnen

A. Independent Claims 1, 10, 20, and 24

1. *Elements [1pre], [10pre], [20pre], [24pre], and [24a]*

173. Zumbrunnen explains the effect of chaotic advection in a blending system that can be used with "polymer melts for extruding" shapes such as "cast and blown film, sheet, rod, tubing, fibers, and other plastic products." RPI1012 at 401. Zumbrunnen further teaches that dies can be used to "form an extrusion into a desired shape and dimension." *Id.* at 403 ("At the extrusion point, the melt is formed by an attached die into a desired extrusion form..."); *id.* at 405 ("[V]arious types of dies can be fitted at a die attachment flange to form extrusions of desired forms.").

174. Zumbrunnen explicitly teaches that one of the plastic products that can be extruded by its system is simulated wood, which it describes as a "[p]lastic[]...with the appearance of realistic wood grains *both inside and on surfaces of [the] extrusions.*" *Id.* at 401. Pointing to Figure 22.12, Zumbrunnen teaches that by "extruding [its] structure melt through a die, the various wood grain patterns in Figure 22.12 form" and that, "[l]ike cut wood, the simulated grain appears

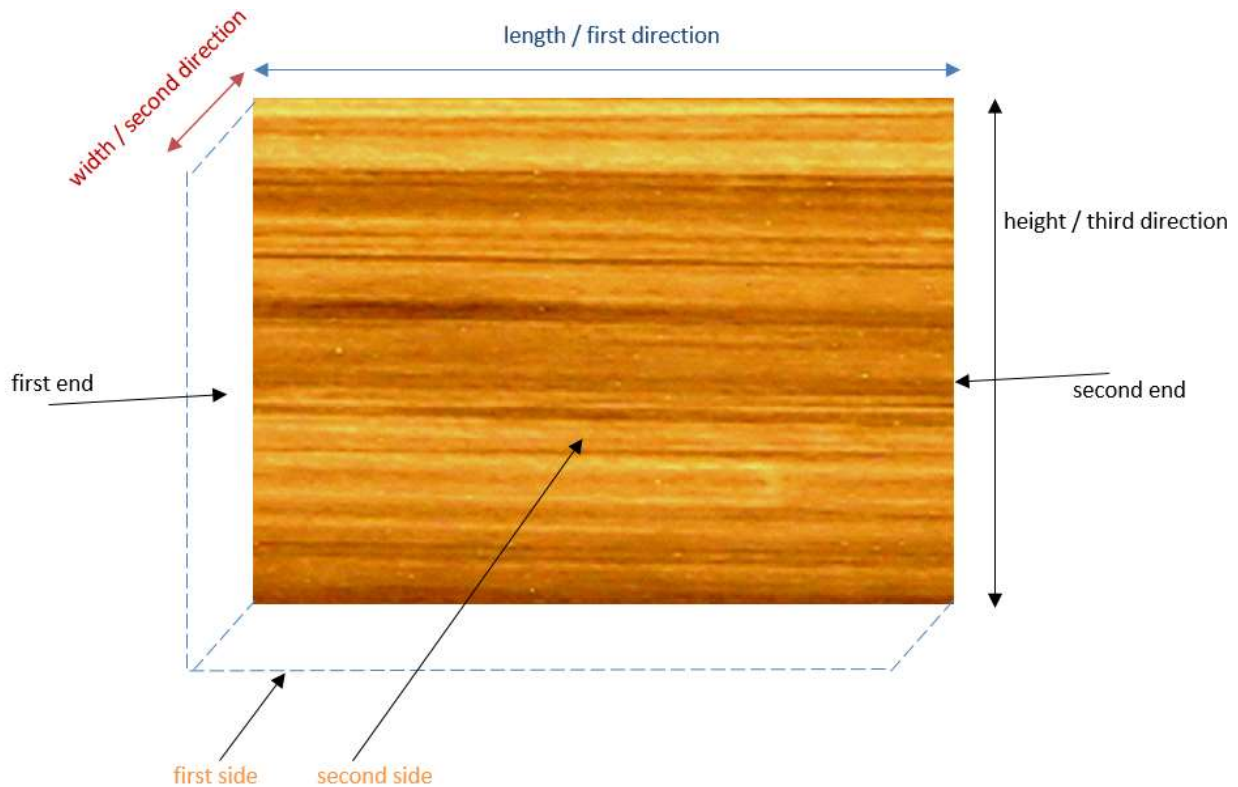
both on the surface and interior of [the] extrusions.” *Id.* at 413 (describing the creation of “[r]ealistic simulated wood grain patterns formed controllably in extruded film” and “an ability to produce an infinite variety of simulated wood patterns”). Zumbrunnen further teaches that pigmented polymer resins can be obtained that are “intended specifically to impart wood appearance.” *Id.*

175. Because Zumbrunnen expressly teaches the creation of three-dimensional plastic products, *e.g.*, “sheet[s], rod[s], tubing,” and “plate[s]” (*id.* at 401, 403), and teaches that its simulated wood products have “the appearance of realistic wood grains both *inside* and on surfaces of [the] extrusions” “[l]ike cut wood” (*id.* at 401, 413), it is my opinion that a person of ordinary skill in the art would have therefore understood that the simulated wood products taught by Zumbrunnen, such as the ones shown in its Fig. 22.12, are also three-dimensional, and that Zumbrunnen therefore discloses “[a] *simulated natural wood-grained polymer board*” ([1pre], [24pre]) or “*substrate*” ([10pre], [20pre]). It is therefore also my opinion that a person of ordinary skill in the art would have understood that the three-dimensional synthetic wood of Zumbrunnen has a non-hollow “*core*” ([10pre]) and, because Zumbrunnen discloses that its wood is a “plastic product[]” made from “polymer resins,” that the core is a “*polymer core*” ([24a]). A person of ordinary skill in the art would have understood this, for example, by

looking at Figures 22.1 and 22.2, which illustrate alternating polymeric layers extending along the entire length and throughout the entire core of Zumbrunnen's synthetic wood, and based on its description of the realistic wood grains both on its surface and on its inside.

176. As I explained above, any difference between the claimed "boards" and "substrates" would at most be one of dimensions. *Supra*, ¶ 109. It is my opinion that a person of ordinary skill in the art would have known how to alter the dimensions of the wood disclosed in Zumbrunnen, either by choosing different dies, as specifically suggested by Zumbrunnen (RPI1012 at 403, 405), and/or through various post-processing steps, such as by cutting the extrudate into variously shaped and dimensioned "substrates" or "boards," depending on the application for which they were intended to be used (*see supra*, ¶¶ 29, 35).

177. It is also my opinion that Zumbrunnen discloses each of the dimensional requirements of the claimed simulated wood set forth in [1pre], [10pre], [20pre], [24pre], and [24a], as can be seen with reference to Figure 22.12 below:



RPI1012 at Fig. 22.12 (annotated).

178. It is my opinion that, as can be seen above, the simulated natural wood-grained polymer board of Zumbrunnen ([1pre]), including its polymer core ([24a]) has a “*first side and a second side spaced apart from the first side, [the ([1pre])] spacing between the first and second sides defining ... a width ... of the*” board or core, “*the first and second sides extending along a length direction [of the core ([24a])] between a first end and a second end, the first and second ends defining a length of the*” board or core. Similarly, it is my opinion that the simulated natural wood-grained polymer substrate of Zumbrunnen “*extend[s] along a first direction,*

the substrate having a first side and a second side spaced apart from the first side along a second direction different than the first direction, the first and second sides defining a width of the substrate, the first and second sides extending along the first direction, a core of the substrate extending between the first and second sides and along the first direction” ([10pre]) and has “a length defined along a first direction, a width defined along a second direction perpendicular to the first direction, and a height defined along a third direction perpendicular to both the first and second directions” ([20pre]). It is my opinion that each of these dimensions and spatial relationships is reflective of nothing more than those of a rectangular board or substrate. As I explained above, the core is the interior of Zumbrunnen’s synthetic wood, which is non-hollow and is made up of the polymeric layers extending along the entire width, along the entire length, and alternating along the height direction.

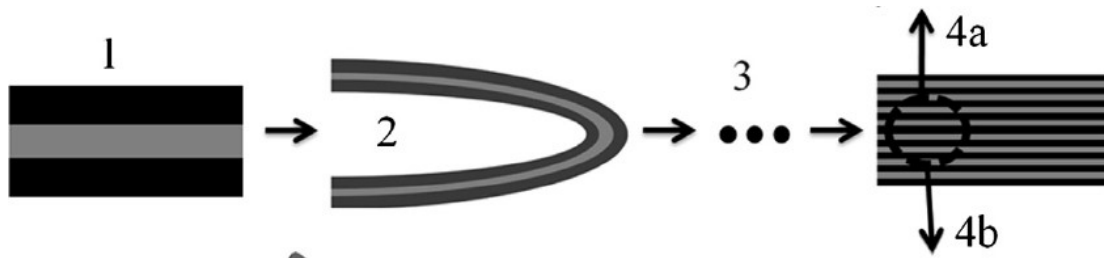
179. Should PO argue that Zumbrunnen does not explicitly disclose an extruded three-dimensional board or substrate with the dimensional and spatial relationships shown above, it is my opinion that it would have been an obvious modification. As I discussed above, Zumbrunnen discloses extruding three-dimensional shapes such as rods, tubing, and plates. RPI1012 at 401. It is my opinion that a person of ordinary skill in the art would have recognized that the final shape of an extrusion can be controlled by the mold or die used at the end of the process.

Supra, ¶ 29. Indeed, Zumbrunnen explicitly teaches this, as I discussed above. RPI1012 at 403 (“At the extrusion point, the melt is formed by an attached die into a desired extrusion form...”); 405 (“[V]arious types of dies can be fitted at a die attachment flange to form extrusions of desired forms.”).

180. Thus, in order to produce Zumbrunnen’s plastic product “with the appearance of realistic wood grains” such that “[l]ike cut wood, the simulated grain appears both on the surface and interior of [the] extrusions,” it is my opinion that a person of ordinary skill would have been motivated to extrude a three-dimensional plastic wood product having the claimed spatial relationships or to cut it into such a shape. *Id.* at 401, 413. Because passing plastic products through a die or cutting them in order to impart a desired shape was known, it is also my opinion that a person of ordinary skill would have had a reasonable expectation of success in shaping the plastic lumber produced by Zumbrunnen to have the dimensional and spatial relationships claimed. My opinion is further confirmed by the ’350 patent’s generic statements that its plastic lumber products having various “profiles” can be “created using a die,” and can be post-processed, such as by cutting, without providing any further information as to the die itself. *E.g.*, RPI1001 at 3:40-51, 6:16-23, 6:63-7:7.

2. *Elements [1a] and [1b], [10a] and [10b], [20a] and [20b], [24b] and [24c]*

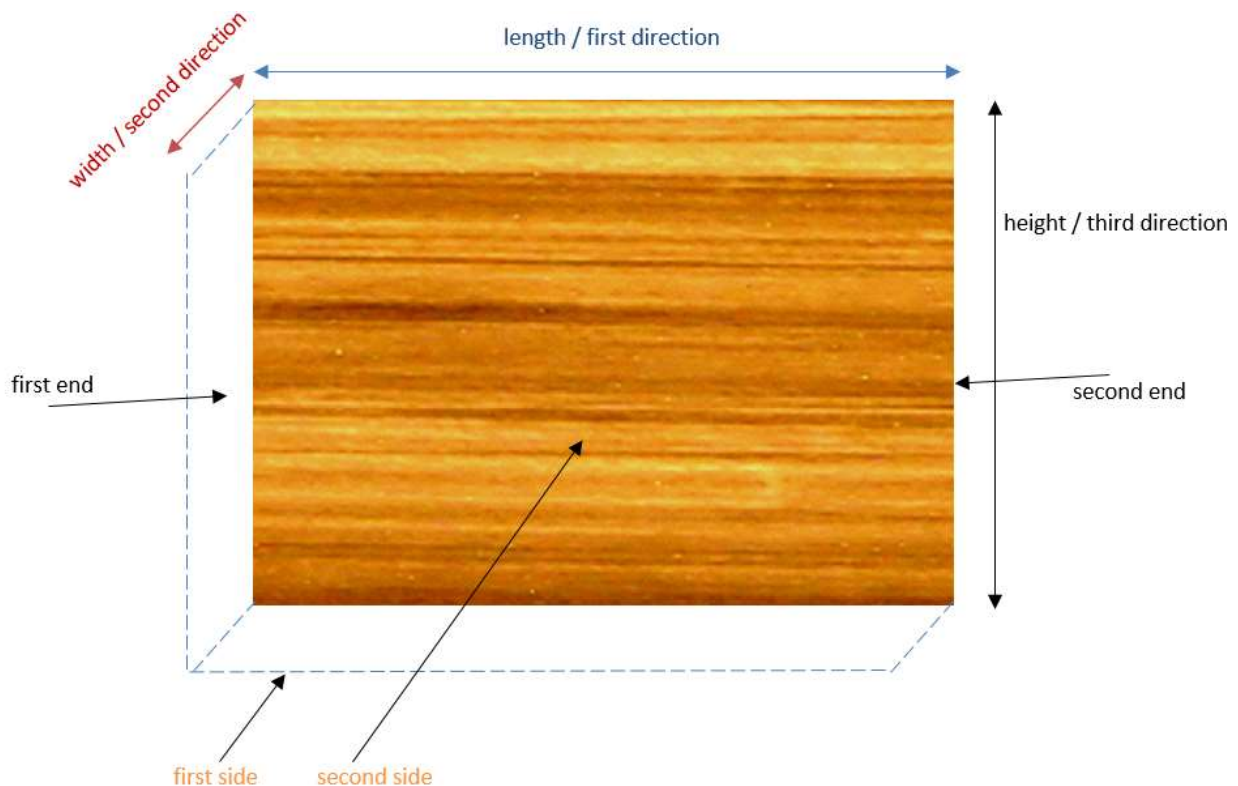
181. Zumbrunnen generally teaches that the chaotic advection caused by its blender results in mixing two “initially large melt domains (e.g., resin pellet size or larger) or melt streams,” which are then “stretched and folded...into alternating multilayers.” RPI1012 at 402. Zumbrunnen illustrates this stretching and folding with reference to Steps 1-3 of its figure 22.1:



Id. at Fig. 22.1. Zumbrunnen specifically describes the folding as being of a “two component polymer melt.” *Id.* at 402. Indeed, Zumbrunnen expressly teaches that the “polymer A and polymer B melts are stretched and folded by chaotic advection...to give the multi-layer morphology at *state 2*,” and that “[f]ew layers lead to a larger number of layers (*state 3*).” *Id.* at 401, 406. It is my opinion that, as can be seen in Figure 22.1, above, this results in a “*first set*” (e.g., the darker colored layers) and a “*second set of polymer layers*” (e.g., the lighter colored layers).

182. Zumbrunnen further teaches that “[d]esired colors” can be “obtained by using pigmented polymer resins such as those from colorant manufacturers intended specifically to impart wood appearance.” RPI1012 at 413. Zumbrunnen also teaches

that by extruding its “structured melt through a die...various wood grain patterns” are formed, and further that those “simulated wood grain patterns can be repeated at intervals along an extrusion.” *Id.* at 413. Figure 22.12 illustrates a resulting polymer board or substrate having alternating polymer layers, of different colors, extending along its length:



Id. at Fig. 22.12 (annotated).

183. As can be seen in Figures 22.1 and 22.12 above, it is my opinion that the synthetic wood of Zumbrunnen comprises “a first set of polymer layers extending along the length direction and containing a first colorant, a majority of the first set of polymer layers extending along the [entire ([24b])] length of the [entire ([1a])]”

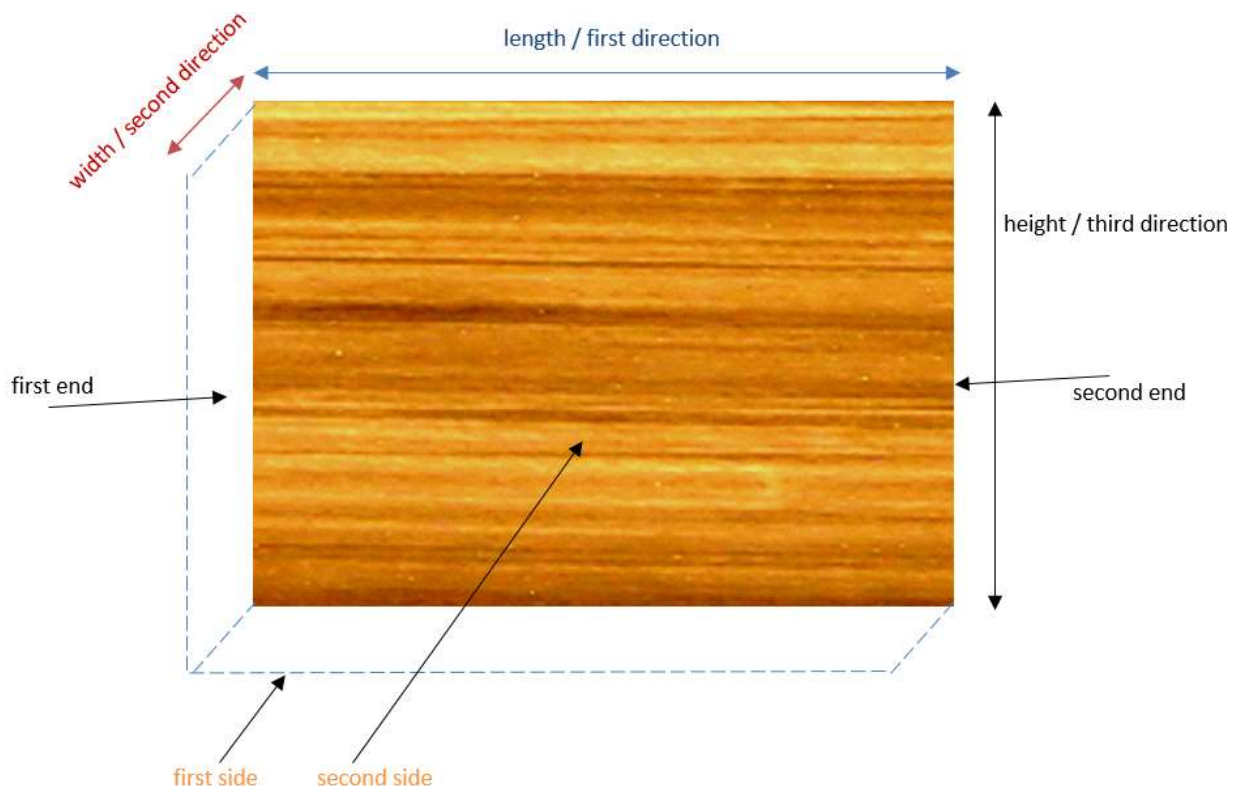
board ([1a]) or core ([24b]) (e.g., the darker brown color, or darker gray in Fig. 22.1) and “a second set of polymer layers extending along the length direction and containing a second colorant different than the first colorant, a majority of the second set of polymer layers extending along the [entire ([24c])] length of the [entire ([1b])]

board ([1b]) or core ([24c]) (e.g., the lighter brown color, or lighter gray, in Fig. 22.1). It is likewise my opinion that the substrates of **Claims 10** and **20** similarly comprise “a first set of polymer layers extending along the first direction and containing a first colorant, a majority of the first set of polymer layers being substantially continuous along the first direction” and “a second set of polymer layers extending along the first direction and containing a second colorant different than the first colorant, a majority of the second set of polymer layers being substantially continuous along the first direction.” Most, if not all, of the lighter and darker polymer layers extend continuously along the entire length direction without any breaks, intersections, or the like. It is therefore my opinion that a “majority of” each of “the first” and “second set of polymer layers” is therefore “substantially continuous along the first direction.”

3. Elements [1c], [10c] and [10d], [20c] and [20d], and [24d]:

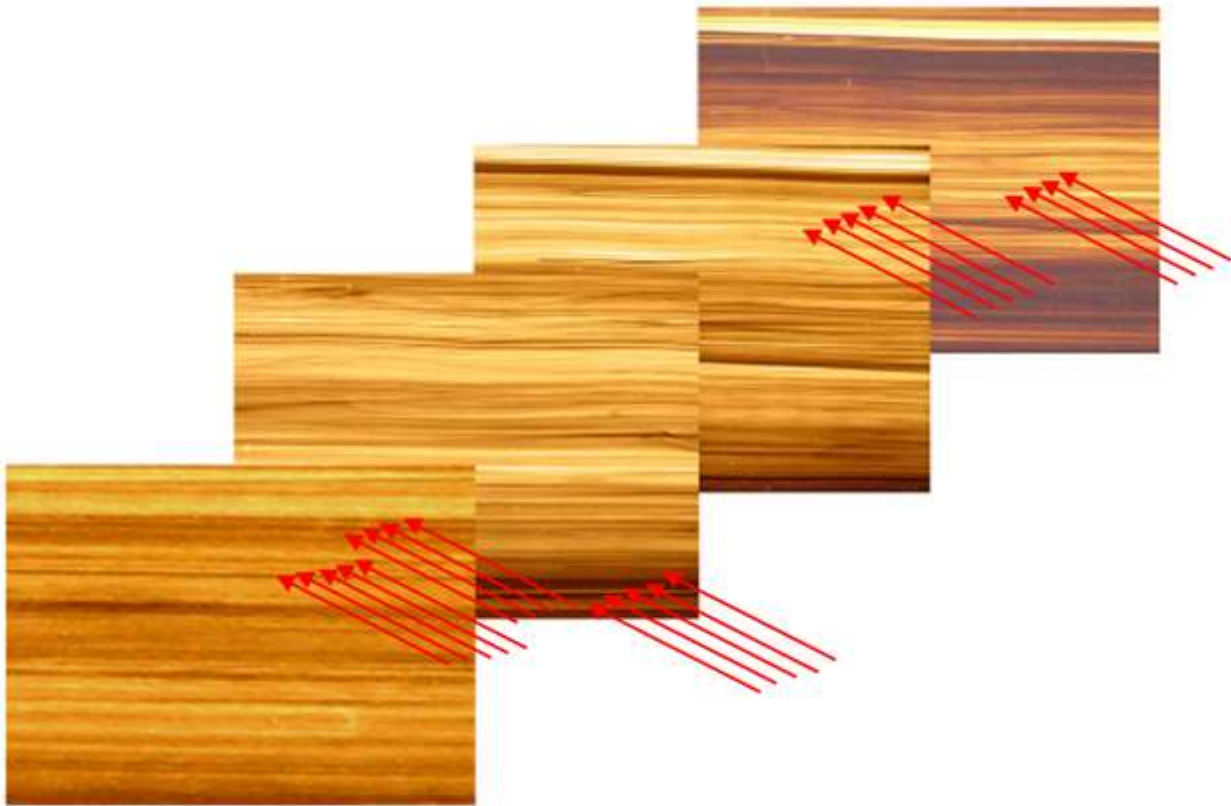
184. Zumbrunnen teaches that the “realistic wood grains” of its plastic wood appear on “both inside and on surfaces of the extrusions,” “[l]ike cut wood.” RPI1002 at 401, 413. Because this pattern is consistent along the length of the wood

that results from the extrusion process, it is my opinion that a person of ordinary skill in the art would have understood that the same pattern of alternating two-color layers that can be seen on the “second side” of the wood shown in annotated Fig. 22.12 below would also exist throughout its core. That is, a person of ordinary skill in the art would have understood that the wood would have each of the lighter and darker polymer layers extend along the entire width or second direction (i.e., from the first side to the second side), as illustrated in annotated Fig. 22.12 below, with the lighter and darker colored layers alternating with one another along the height or third direction:



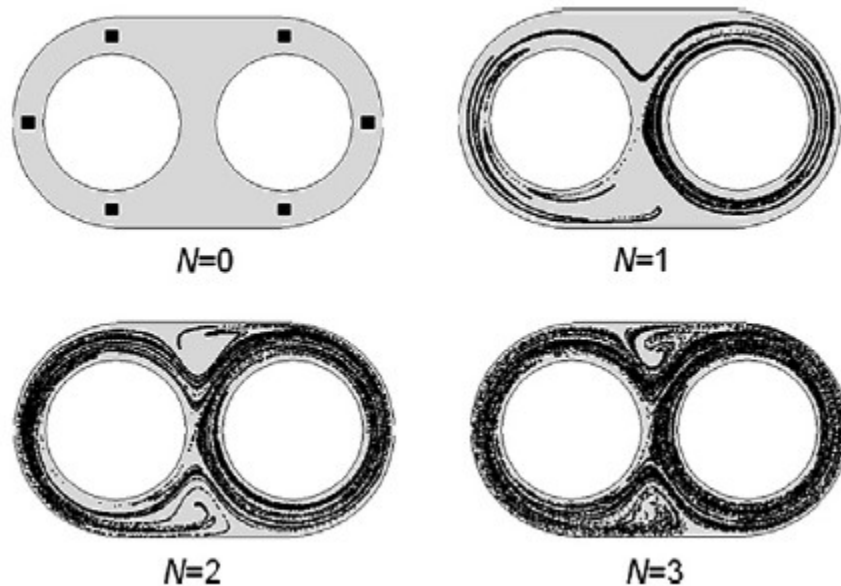
Id. at Fig. 22.12 (annotated).

185. Because of the nature of the extrusion process, and of Zumbrunnen's disclosure that its simulated "wood grain patterns can be repeated at intervals along an extrusion" (i.e., remain unchanged) (*id.* at 413), it is my opinion that a person of ordinary skill in the art would have also understood that the uninterrupted, curved polymeric layers that can be seen on the "second side" in annotated Fig. 22.12 above would likewise extend along the entire width or second direction (i.e., from the first side to the second side). The continuous, curved nature of Zumbrunnen's polymer layers can be more clearly seen in the examples of the "infinite variety of simulated wood patterns" that Zumbrunnen provides. Such exemplary alternating layers are annotated below, though additional ones are apparent to the naked eye throughout:



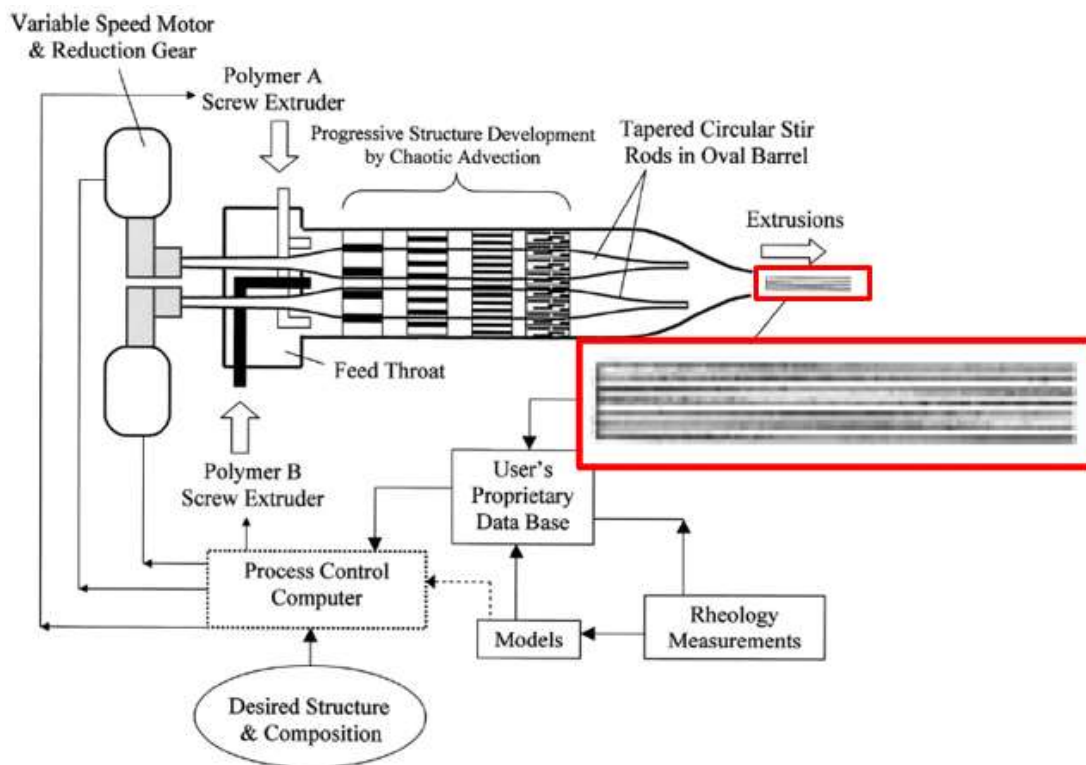
Id. at 412-13, Fig. 22.12. And as Zumbrunnen itself notes, these layers can be arranged in an “infinite variety of...patterns.” RPI1012 at 413.

186. My opinion is further confirmed by Zumbrunnen’s Fig. 22.2, which shows a cross-section of the wood grain pattern inside the resulting wood based on the number of “rod rotational speed changes” of the pairs of mixing rods in the chaotic mixer while the “melt is resident in the smart blender”:



Id. at 404, Fig. 22.2 (annotated).

187. It is my opinion that, as can be seen from Fig. 22.2 above, the alternating polymer layers extend throughout the inside of the entire melt both in the horizontal and the vertical direction. When the rods are arranged vertically to one another, Zumbrunnen teaches that the resulting extrusion has a horizontally-oriented polymeric layer arrangement as shown in Figs. 22.1 and 22.12, which a person of ordinary skill in the art would understand to continue throughout the inside of the wood:



Id. at Fig. 22.2 (annotated). A person of ordinary skill in the art would have also understood that by arranging the stir rods horizontally relative to one another, a vertically-oriented polymer layer arrangement could be achieved within the core, consistent with the surfaces shown in Figure 22.12.

188. Thus, it is my opinion that Zumbrunnen discloses that “a plurality of individual layers of the first and second sets of polymer layers alternate within the” board ([1c]) or core ([24d]) “and extend along a substantially uninterrupted curvilinear path originating proximate the first side of the” board ([1c]) or core ([24d]) “and terminating proximate the second side of the” board ([1c]) or core ([24d]). Similarly, Zumbrunnen discloses that the “individual layers of the first and

second sets of polymer layers alternate within the [core of the ([10c])] substrate [along the third direction ([20c])] to form a natural wood-grained appearance throughout the [core of the ([10c])] substrate” and that “a plurality of the individual layers of one of the [plurality of the ([20d])] first and second sets of polymer layers extend along a substantially uninterrupted curvilinear path in the second direction originating proximate [the first side and terminating proximate the second side ([10d]) / an outer surface of a first portion of the substrate and terminating proximate an outer surface of a second portion of the substrate ([20d])].” As I discussed earlier, these alternating individual sets of polymer layers are what give the wood of Zumbernen its “simulated grain” appearance “both on the surface and interior” discussed above (RPI1012 at 401, 413) and thus “*form a natural wood-grained appearance throughout the*” substrate or its core. Should PO argue, notwithstanding the above, and notwithstanding the fact that the Figures of the ’350 patent show graining terminating and originating further away from the sides and surfaces, that there is not a plurality of these layers that “*terminate*” and “*originate*” “*proximate*” the sides of the board/substrate/or its core, or the substrate’s outer surfaces, this could be easily accomplished by post-processing the substrates/boards, by cutting them (as was known) so that the grain patterns extend along the entire width, as they do along the entire length. *See supra*, ¶¶ 35, 176, 181-83.

B. Claims 2, 11, and 21

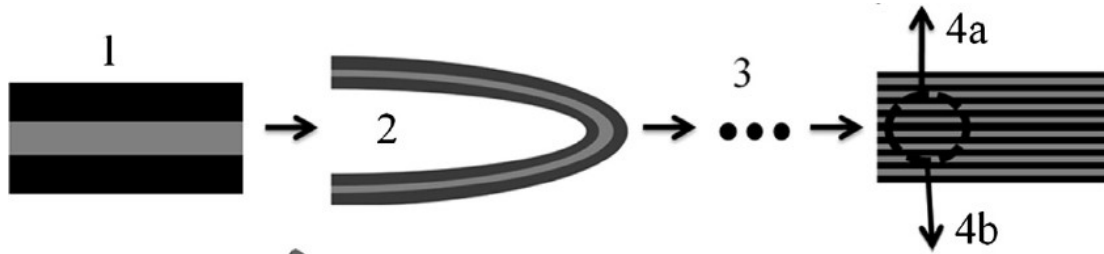
189. It is my opinion that, as can be seen in Figure 22.12 of Zumbrunnen, its “*first set of polymer layers*” (e.g., the darker brown color layers) “*are thinner than the layers of the second set of polymer layers*” (e.g., the lighter brown color layers):



RPI1012 at Fig. 22.12 (annotated).

190. Should PO argue that Zumbrunnen does not disclose the first set of polymer layers being “*thinner*” than the second, it is my opinion that such an arrangement would have been obvious. Zumbrunnen teaches “[t]he ability to produce an infinite variety of simulated wood patterns.” RPI1012 at 413. It also expressly states that its method of “stretching and processing can be continued to give a desired layer thickness in an extrusion.” *Id.* at 402. It is therefore my opinion

that a person of ordinary skill in the art would have understood, including from looking at Fig. 22.1, that by introducing more of one polymer than the other, the stretching and folding will result in thicker layers of the colored polymer that was introduced in greater amounts as compared to the other colored polymer:



Id. at Fig. 22.1.

191. Indeed, Zumbrunnen illustrates numerous examples of simulated wood grain patterns in which the polymer layers, at a minimum, vary in thickness depending on the design desired:



Id. at Fig. 22.12. And because Zumbrunnen expressly discloses creating “realistic wood *grains*” (*id.* at 401), it is my opinion that a person of ordinary skill would have been motivated to make the darker layers thinner than the others in order to achieve such a graining effect and been able to do so (e.g., by introducing the polymer layers in different amounts, as I just explained).

C. Claim 3

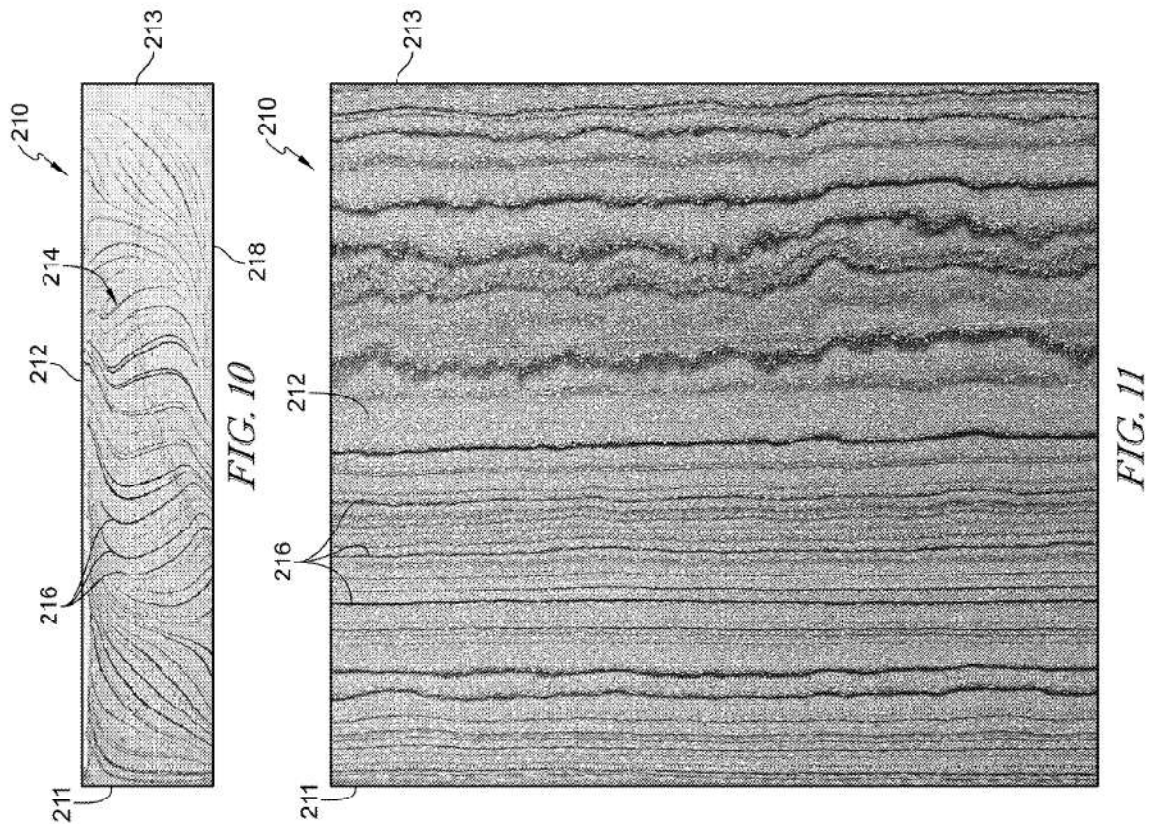
192. As I discussed above, Zumbrunnen teaches that its simulated wood products have “the appearance of realistic wood grains both *inside* and on surfaces of the extrusion” “[l]ike *cut wood*” (RPI1012 at 401, 413). As I further explained above, this graining extends from one side of the board to the other, as well as along its entire length direction. *Supra*, ¶¶ 181-88. The polymer layers also follow a curved

pattern from side to side and alternate with one another, as I explained. *Supra*, ¶¶ 181-88. Thus, it is my opinion that a person of ordinary skill in the art would have understood that if the wood of Zumbrunnen were cut so as to remove a portion of at least one of the first or second sides of the board, this would expose portions of the first and second sets of polymer layers along the length direction. Indeed, Zumbrunnen repeatedly describes its realistic wood grains as extending through the inside, and not only on the surface. *Id.* at 401, 413. It is also my opinion that a skilled artisan would have understood that removal of at least one of the first or second sides of the board may occur if the board were cut along (and parallel to) its length direction, or if it were planed. The '350 patent itself recognizes that both cutting and planing of plastic lumber was known and done before the alleged invention of the '350 patent, and does not constitute an inventive aspect of the patent. RPI1001 at 1:31-37; *supra*, ¶35. These would have been ordinary, known post-processing steps intended to get the correct dimensions of the lumber and to smoothen it, respectively, for the application at hand. *Supra*, ¶35.

193. Accordingly, it is my opinion that Zumbrunnen discloses Claim 3's additional requirement of a board "*wherein a portion of at least one of the first side and second side of the board is removed to expose portions of the first and second sets of polymer layers along the length direction.*"

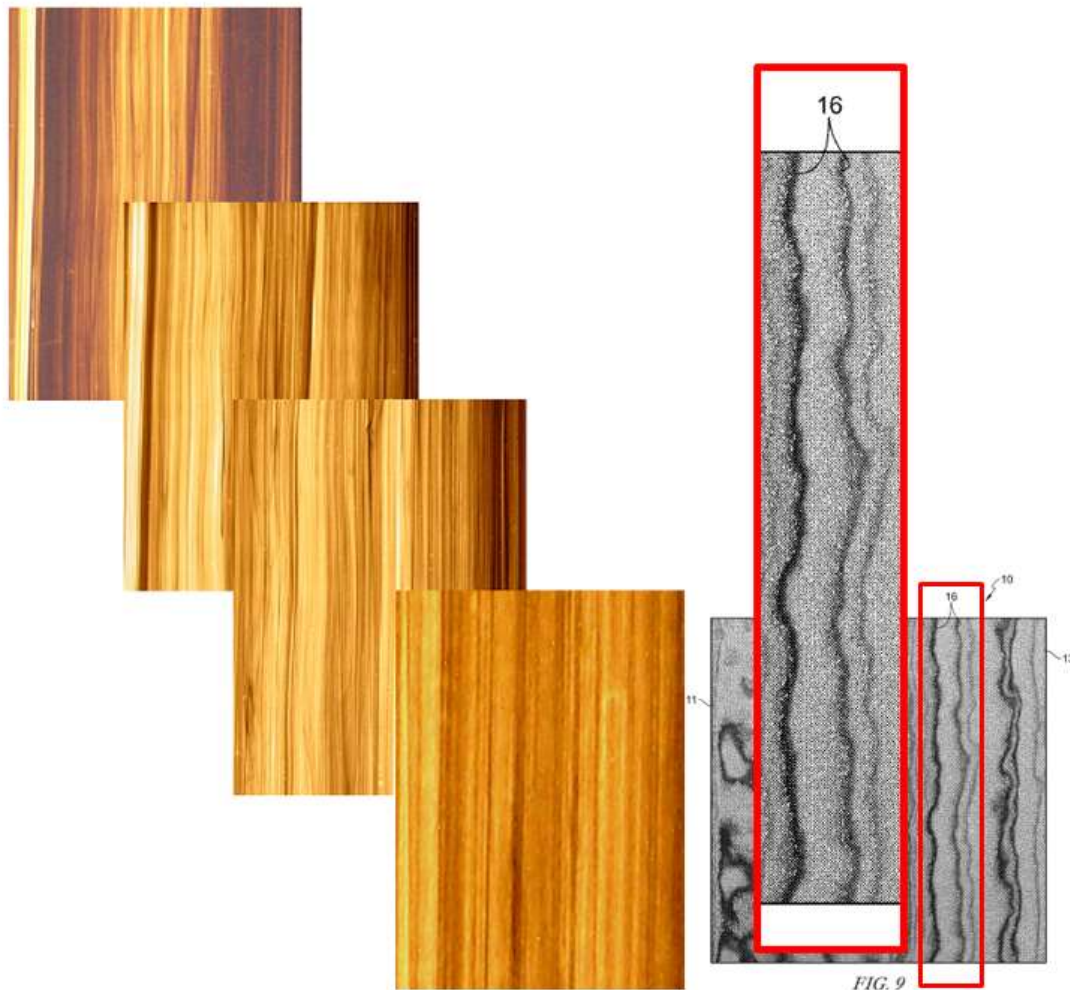
D. Claim 4

194. As I explained earlier, the '350 patent discloses that a “burled grain” pattern is what necessarily results from planing the surface of a board that has internal graining formed from the claimed polymer layers, so long as those layers do not terminate at a perpendicular angle to the surface. *Supra*, ¶¶85-90. As I further described above, the graining in Zumbrunnen’s wood extends through its inside, and would therefore result in internal graining similar to the internal graining in Fig. 10 of the '350 patent:



RPI1001 at Figs. 10, 11. Thus, it is my opinion that a skilled artisan would have understood that planing the board of Zumbrunnen, with its curved grain patterns that therefore would not run perpendicular to the surface, would result in a burled grain pattern being exposed, within the meaning of the '350 patent.

195. In my opinion, the grains 16 to which the '350 patent points as an example of “a burled grain pattern” in its Fig. 9, for example, are virtually indistinguishable from the multitude of grains disclosed in Zumbrunnen:



RPI1012 at Fig. 22.12; RPI1001 at Fig. 9, 6:38-43.

196. It is therefore my opinion that Zumbrunnen discloses Claim 4's additional requirement of a board "*wherein the exposed portions of the first and second sets of polymer layers*" of Claim 3 "*form a burled grain pattern.*"

E. Claims 6, 12, and 22

197. As I discussed above, Zumbrunnen teaches that its invention is directed to forming "plastic products" from "polymers." RPI1012 at 401. And it expressly teaches an example using HDPE (in combination with LDPE) as the polymer in its first and second sets of polymer layers. RPI1012 at 408 ("The potential amount of layer refinement obtained with a smart blender is demonstrated for a blend consisting of 15% by volume [low density polyethylene] LPDE and ***high density polyethylene (HDPE)***."). It is therefore my opinion that Zumbrunnen teaches that the "*first and second sets of polymer layers are formed from high density polyethylene.*"

198. It is additionally my opinion that a person of ordinary skill would have found it obvious to use HDPE as the polymeric material. For the reasons I discussed in Ground 1, HDPE was one of the most commonly used types of polymers in simulated wood production prior to the '350 patent, including in extruded simulated wood products, and there were several known benefits to its use. *Supra*, ¶¶145-47. Thus, for the same reasons I described in Ground 1, it is my opinion that a person of ordinary skill would have been motivated to use HDPE to form the first and second

sets of polymer layers in Zumbrunnen and would have had a reasonable expectation of success in doing so. *Supra*, ¶148.

F. Claims 9 and 15

199. As I discussed with respect to the independent claims, Zumbrunnen discloses a three-dimensional, rectangular simulated wood board or substrate. *Supra*, ¶¶ 173-76. It further discusses the simulated wood having natural wood grain appearing throughout its inside, “[l]ike cut wood.” RPI1012 at 413. Zumbrunnen also discloses using a die to create the desired shape of the product, which a person of ordinary skill in the art would have understood to include such a three-dimensional rectangular shape. *Id.* at 403 (“At the extrusion point, the melt is formed by an attached die into a desired extrusion form...”); *id.* (“dies serve only to form an extrusion into a desired shape”). It is my opinion that a person of ordinary skill in the art would have therefore understood that the three-dimensional, rectangular wood boards and substrates disclosed in Zumbrunnen would have, at a minimum, a rectangular (and therefore polygonal) cross-section along their length. Accordingly, it is my opinion that Zumbrunnen discloses a board or substrate that “*is formed to define a polygonal cross-section along [its] length.*” It is my further opinion that it would have been obvious to give the board or substrate such a shape through post-processing or by using a die with the desired profile, for the reasons I discussed above, not least of which being to simulate the shape of a natural wood board and

for the board to be used as lumber. *See supra*, ¶¶36, 173-76, 179-80; RPI1033 at 1 (defining plastic lumber as being “typically used as a building material for purposes similar to those of traditional lumber, which is usually rectangular in cross-section”).

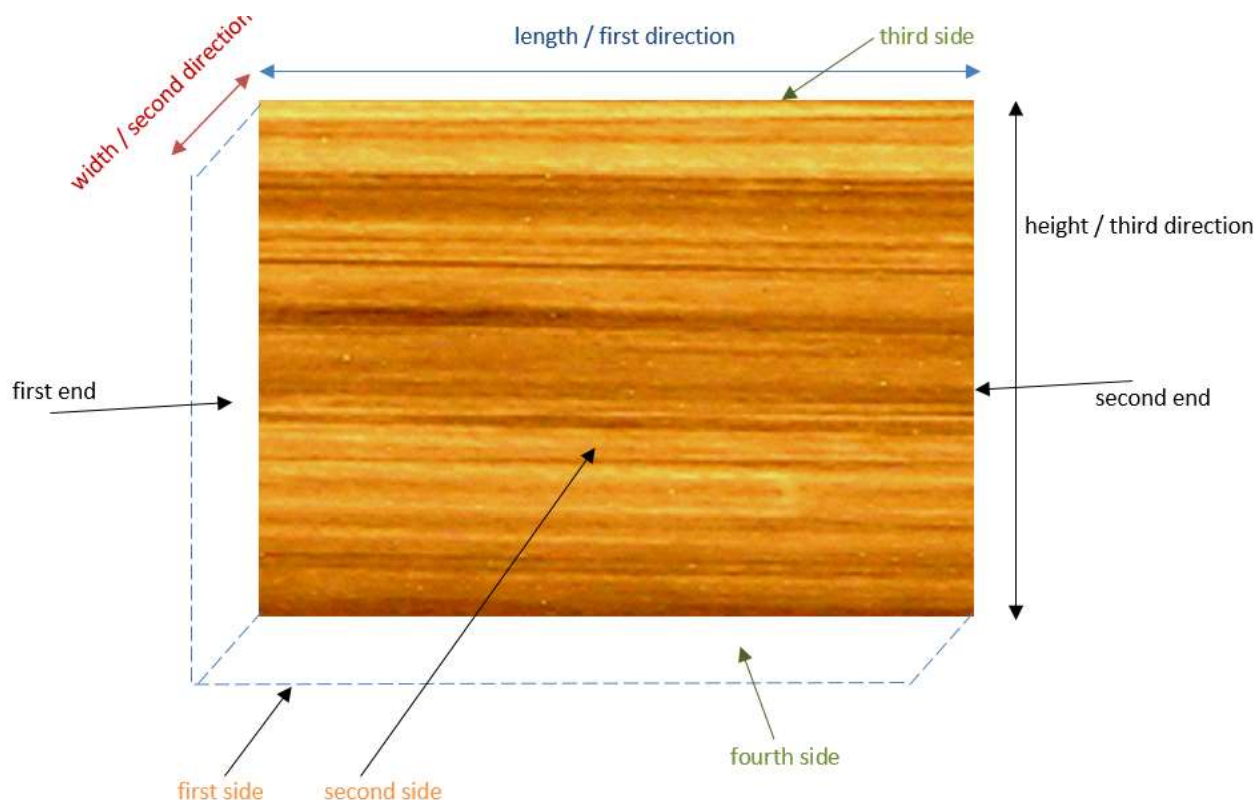
G. Claims 16, 18, and 23

200. Zumbrunnen is directed to the extrusion of “plastic materials.” RPI1012 at 401. Although it has a section discussing “Polymer-Solid Composites and Nanocomposites,” I did not see any mention of adding any natural wood materials. *Id.* at 408-11. Instead, the only additives Zumbrunnen discusses are “[i]norganic solids such as carbon black, nanoclays, graphene, nanotubes, and nanofibers.” *Id.* at 408. Nor does Zumbrunnen teach that any of the additives that it mentions are required, but rather that they “can” be added and that they “can” improve certain features. *E.g., id.* It is therefore my opinion that Zumbrunnen teaches that its plastic wood can be created from polymers, without the need for any natural wood materials, and therefore that Zumbrunnen discloses the claimed board of Claim 6, and the claimed substrates of Claims 12 and 22, “*wherein the core is substantially free of natural wood materials.*”

H. Claims 17 and 19

201. **Claims 17 and 19**, which depend from **Claims 1 and 10**, respectively, merely recite a third dimension to the claimed board and substrate. For largely the same reasons discussed with respect to elements **[1pre]**, **[10pre]**, **[20pre]**, and

[24pre-24a] above, and with reference to annotated Figure 22.12 below, it is my opinion that Zumbrunnen discloses each of these additional dimensional limitations:



RPI1012 at Figure 22.12 (annotated).

202. Because the wood of Zumbrunnen is rectangular and three-dimensional, as I discussed earlier, it will include a “*height*” or “*third direction*.” Thus, it is my opinion that, as can be seen in Figure 22.12 above, the wood of Zumbrunnen comprises “*a third side and a fourth side spaced apart from the third side along a [height (Claim 17) / third (Claim 19)] direction different than the [length direction and width direction (Claim 17) / first and second directions (Claim 19)], wherein the third and fourth sides define a height of the [board (Claim*

17) / substrate (**Claim 19**)], wherein the third and fourth sides extend along the [length (**Claim 17**) / first (**Claim 19**)] direction [between the first and second ends (**Claim 17**)].”

203. As I also previously discussed, the three-dimensional synthetic wood of Zumbrunnen includes a “core” and the woodgrain pattern extends throughout that core. *E.g., supra*, ¶¶ 173-75; 173-88. Thus, with reference to Figure 22.12 above, it is also my opinion that Zumbrunnen discloses that “the core of the [board (**Claim 17**) / substrate (**Claim 19**)] extends between the first, second, third, and fourth sides [and between the first and second ends (**Claim 17**) / and along the first direction (**Claim 19**)], and wherein the individual layers of the first and second sets of polymer layers alternate within the core of the [board (**Claim 17**) / substrate (**Claim 19**)] along the [height (**Claim 17**) / third (**Claim 19**)] direction.”

204. Should PO argue that Zumbrunnen does not disclose a three-dimensional board or substrate with the dimensional and spatial relationships shown above, it would have been an obvious modification, for the same reasons described with respect to elements [1pre], [10pre], [20pre], [24pre], and [24a]. *Supra*, ¶¶ 176, 179-80.

205. It is further my opinion that, for the reasons set forth regarding elements [1c], [10c-10d], [20c-20d], and [24d], Zumbrunnen discloses that “the individual

layers of the first and second sets of polymer layers alternate within the core of the” board or substrate “along the height/third direction.” Supra, ¶¶ 184-88.

XI. Ground 4: Claims 5, 7-8, and 13-14 Are Obvious Over Zumbrunnen in View of Rassi

A. Claim 5

206. As I discussed with respect to Ground 2, Rassi provides an example in the prior art of extruded plastic lumber having embossed surfaces. *Supra*, ¶¶156-57. Rassi, like Zumbrunnen, teaches plastic lumber created through an extrusion process. RPI1013 at Abstract, 1:10-62, 1:66-2:20. Rassi, like Zumbrunnen, is also concerned with creating plastic lumber that is “aesthetically pleasing, exhibiting a ‘natural’ look like the look of grains in wood boards,” and having a “graining pattern [that] extends into the core of the board,” and not limited to its surface. RPI1013 at 5:63-65; 1:25-62; 10:31-33. Rassi further teaches that the look and feel of any outer surface of such simulated wood boards can be “augmented by ***embossed grain-like patterns***” to further “mimick[] the look of real wood” and provide a “grain-like texture.” RPI1013 at 1:32-33, 1:48-50, 3:20-22, 6:6-10, 12:11-12; *supra*, ¶¶ 156-57.

207. It is therefore my opinion that a person of ordinary skill would have been motivated to emboss the surfaces of the wood created by Zumbrunnen, as taught by Rassi, in order to further Zumbrunnen’s goal of producing plastics “with the appearance of realistic wood.” RPI1012 at 401. It is also my opinion that a skilled

artisan would have been motivated to emboss the plastic lumber's surfaces for antislip reasons. RPI1033 at 6, § 6.5; *supra*, ¶ 158. For the reasons I discussed in Ground 2, a person of ordinary skill in the art would have been motivated to apply the embossing disclosed in Rassi to the synthetic wood in Zumbrunnen, and had a reasonable expectation of success in doing so. *Supra*, ¶¶ 35, 159.

208. It is therefore my opinion that a person of ordinary skill in the art would have found it obvious to “*emboss[] with a wood grain pattern*” “*at least one of the first and second sides of the board*” of Zumbrunnen in view of Rassi.

B. Claims 7 and 13

209. As I discussed above, Rassi, like Zumbrunnen, discloses plastic lumber created through an extrusion process that is intended to resemble the look of real wood both on its surface and inside. Rassi further teaches that its extruded polymers include various additives, such as “chemical *foaming agents (CFA's)*, ... and *UV stabilizers*.” RPI1013 at 6:40-42. Rassi particularly emphasizes that its polymeric resins include chemical foaming agents. *Id.* at 2:47-51. Rassi also makes clear that its polymer resins each include a color additive, which in turn “typically includes UV stabilizers.” *Id.* at 2:52-59; 7:1-4; *supra*, ¶161.

210. With respect to the foaming agents, Rassi teaches that they are utilized to form “void spaces,” which can “provide texture to the outer surface” of the plastic lumber that makes them “closer to the feel of real wood” and that also “permit the

board ... to retain stains.” *Id.* at 5:67-6:12. It is my opinion that a person of ordinary skill would have also understood that foaming agents will affect the density of an object. *Supra*, ¶162. To that end, Rassi teaches that the “[d]ensity” of its plastic lumber “is varied to achieve a desired mechanical performance (i.e.: flexural strength, screw retention, brittleness etc.).” RPI1013 at 6:40-46.

211. In my opinion, a person of ordinary skill would have therefore been motivated to add foaming agents, as taught by Rassi, into the polymer layers of the wood boards produced by Zumbrunnen. Doing so would have furthered Zumbrunnen’s goal of producing plastics “with the appearance of realistic wood.” RPI1012 at 401. Specifically, using foaming agents would “provide texture to the outer surface” of the plastic lumber that is “closer to the feel of real wood” and permit it to be stained. RPI1013 at 5:67-6:12. A person of ordinary skill in the art would have also understood that foaming agents can reduce the weight of polymer boards, thus reducing transportation costs and the weight of any end products, and reduce their material costs, providing additional motivation to implement them. *See* RPI1031 at 17; RPI1022 at 5:20-35, 10:49-11:5, 14:24-32; RPI1011 at [0007] (discussing the need to reduce the cost of synthetic wood); *supra*, ¶37. Furthermore, Zumbrunnen expressly contemplates “additives” being used in its polymer melts. *E.g.*, RPI1012 at 403, 408, 411.

212. With regard to UV inhibitors, it is my opinion that a person of ordinary skill would have known that they could be used to prevent color and structural degradation from constant exposure to sunlight. RPI1013 at 6:40-42; RPI1032 at [0015]; RPI1029 at vii; RPI1016 at 143; *supra*, ¶37. In other words, UV inhibitors help increase the aesthetic longevity and the durability of simulated wood boards. It is my opinion that a person of ordinary skill would have therefore been motivated to add UV inhibitors, as taught by Rassi, into the polymer layers of the wood boards produced by Zumbrunnen for these very purposes. This is especially true in view of Zumbrunnen's stated goal of having plastic wood "with the appearance of realistic wood," which the UV inhibitors would help prevent from deteriorating, especially where the plastic lumber is intended for use outdoors. *See* RPI1012 at 401; *supra*, ¶37; RPI1033 at 1 (defining plastic lumber as being "typically used as a building material for purposes similar to those of traditional lumber"). And I again note that Zumbrunnen expressly contemplates "additives" being used in its polymer melts. *Id.* at 403, 408, 411.

213. Because adding UV inhibitors and foaming agents into the polymeric layers of plastic lumber during the extrusion process was a known process, it is my opinion that a person of ordinary skill in the art would have also had a reasonable expectation of success in including these additives in the polymer layers of the

plastic lumber produced by Zumbrunnen, for the same reasons I discussed above with respect to Ground 2. *Supra*, ¶¶ 37, 165.

214. It is therefore my opinion that a person of ordinary skill would have found it obvious to “*include at least one of a UV inhibitor and a foaming agent*” in “*the first and second sets of polymer layers*” of Zumbrunnen’s synthetic wood, in view of Rassi.

C. Claims 8 and 14

215. For the reasons I discussed with respect to Claims 7 and 13, it is my opinion that a person of ordinary skill in the art would have found it obvious to “*include[]a foaming agent*” in “*one of the first and second sets of polymer layers*” of Zumbrunnen’s synthetic wood, in view of Rassi.

XII. Conclusion

216. In my opinion, all of the Challenged Claims are unpatentable in view of the prior art I have discussed and the reasons I have provided above.

217. I reserve the right to supplement my opinions to address any new information that comes to light throughout this proceeding, including any opinions provided by or positions taken by the Patent Owner or its expert, or any additional information that I may receive.

XIII. Signature and Attestation

I hereby declare that all statements made herein of my own knowledge are true and that all opinions expressed herein are my own; and further that these statements were made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.



Karl Englund, Ph.D.

5/7/2024

Date