

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

**FIRST QUALITY RETAIL SERVICES, LLC,
FIRST QUALITY CONSUMER PRODUCTS, LLC,
FIRST QUALITY PRODUCTS, LLC,
FIRST QUALITY ENTERPRISES, LLC,**

Petitioners,

v.

ESSITY HYGIENE AND HEALTH AB.

Patent Owner

Case No. IPR2024-01487

U.S. Patent No. 9,308,138

**EXPERT DECLARATION OF DR. BEHNAM POURDEYHIMI
REGARDING CLAIMS 1-5, 7-8, 20-22 and 24-25 OF
U.S. PATENT NO. 9,308,138**

TABLE OF CONTENTS

I.	Introduction.....	1
II.	Qualifications and Experience.....	1
III.	Legal Principals	4
	A. Scope of Opinion.....	4
	B. Anticipation	5
	C. Obviousness.....	5
	D. Claim Dependency	8
IV.	Materials Considered	9
V.	Level of Ordinary Skill in the art.....	9
VI.	Overview of the Technology	10
	A. Design Constraints and Challenges of Absorbent Articles.....	10
	B. Absorbent Articles May Include Certain Well-Known Structures	17
	1. Topsheet	17
	2. Backsheet	19
	3. Absorbent Layers	20
	4. Fluid Acquisition Layers.....	25
VII.	OverView Of The '138 Patent.....	29
	A. Overview	29
	B. Examination of the '138 Patent Before the United States Patent and Trademark Office	32
VIII.	Overview of the Asserted Prior Art.....	36
	A. Bergstrom-'059	36
	B. Nakazawa-'190.....	38
	C. Glaug-'753.....	40
	D. Ponomarenko-'236	42
	E. Cohen-'429	43
IX.	Claim Construction.....	44
X.	Analysis of the grounds	45

A.	Ground I: Claims 1, 3, 21-22, and 24-25 Are Anticipated By Bergstrom	46
1.	Claim 1	46
a.	1[pre]: An absorbent article having a longitudinal direction and a transverse direction, side edges extending in the longitudinal direction and end edges extending in the transverse direction.	46
b.	1[a]: “a fluid permeable top sheet”	49
c.	1[b]: “a fluid impermeable backsheet”	50
d.	1[c]: “an absorbent core enclosed between said topsheet and said backsheet”	51
e.	1[d]: “said absorbent core comprising, a first absorbent layer having an opening that passes through the first absorbent layer from one major surface to an opposing major surface and therebetween the opening is surrounded by a closed periphery of first absorbent layer”	53
f.	1[e]: “said absorbent core comprising . . . a fluid flow control structure”	55
g.	1[f]: “said absorbent core comprising . . . a second absorbent layer arranged between the fluid flow control structure and the fluid impermeable backsheet”	58
h.	1[g]: “wherein the fluid flow control structure is arranged between said first absorbent layer and said backsheet” ..	59
i.	1[h]: “said fluid control structure being a layered structure comprising a non-perforated fibrous polymeric layer and a first perforated polymeric layer”	61
j.	1[i]: “wherein the opening extends along a longitudinal center line of the absorbent article, the longitudinal center line being in parallel with the longitudinal direction of the absorbent article”	63
k.	1[j]: “the fluid permeable topsheet is in direct contact with the fluid flow control structure via the opening.” ..	66
2.	Claim 3: “The absorbent article according to claim 1, wherein the first perforated polymeric layer is a nonwoven, a film or a film/nonwoven laminate”	67

3.	Claim 21: “The absorbent article according to claim 1, wherein the opening extends through the entire crotch portion of the absorbent article.”	68
4.	Claim 22: “The absorbent article according to claim 1, wherein the fluid permeable top sheet is not perforated.”	70
5.	Claim 24: “The absorbent article according to claim 1, wherein the fluid permeable top sheet is in contact with the first absorbent layer of the absorbent core at an area other than where the opening is located.”	72
6.	Claim 25: “The absorbent article according to claim 1, wherein the fluid permeable topsheet is in contact with the fluid flow control structure via the opening, such that a cavity is formed along the longitudinal center line of the absorbent article.”	73
B.	Ground II: Claims 1, 3-5, 20-22 and 24-25 Are Obvious Over Nakazawa-’190 in view of Glaug-’753	75
1.	Claim 1	75
a.	1[pre]: An absorbent article having a longitudinal direction and a transverse direction, side edges extending in the longitudinal direction and end edges extending in the transverse direction.	75
b.	1[a]: “a fluid permeable top sheet”	77
c.	1[b]: “a fluid impermeable backsheet”	78
d.	1[c]: “an absorbent core enclosed between said topsheet and said backsheet”	79
e.	1[d]: “said absorbent core comprising, a first absorbent layer having an opening that passes through the first absorbent layer from one major surface to an opposing major surface and therebetween the opening is surrounded by a closed periphery of first absorbent layer”	80
f.	1[e]: “said absorbent core comprising . . . a fluid flow control structure”	83
g.	1[f]: “said absorbent core comprising . . . a second absorbent layer arranged between the fluid flow control structure and the fluid impermeable backsheet”	85

- h. 1[g]: “wherein the fluid flow control structure is arranged between said first absorbent layer and said backsheet” .86
- i. 1[h]: “said fluid flow control structure being a layered structure comprising a non-perforated fibrous polymeric layer and a first perforated polymeric layer” 87
- j. 1[i]: “wherein the opening extends along a longitudinal center line of the absorbent article, the longitudinal center line being in parallel with the longitudinal direction of the absorbent article” 97
- k. 1[j]: “the fluid permeable top sheet is in direct contact with the fluid flow control structure via the opening.” ..99
- 2. Claim 3: “The absorbent article according to claim 1, wherein the first perforated polymeric layer is a nonwoven, a film or a film/nonwoven laminate” 100
- 3. Claim 4: “The absorbent article according to claim 1, the first perforated polymeric layer is a three-dimensionally formed layer having penetrating apertures extending from a first surface of the first perforated polymeric layer towards a second surface of the first perforated polymeric layer and forming protrusions on said second surface” 102
- 4. Claim 5: “The absorbent article according to claim 4, wherein the first perforated polymeric layer is arranged with said second surface facing the non-perforated fibrous polymeric layer.” ..104
- 5. Claim 20: “The absorbent article according to claim 1, wherein the basis weight of the non-perforated fibrous polymeric layer is from 20-120 gsm.” 105
- 6. Claim 21: “The absorbent article according to claim 1, wherein the opening extends through the entire crotch portion of the absorbent article.” 106
- 7. Claim 22: “The absorbent article according to claim 1, wherein the fluid permeable top sheet is not perforated.” 107
- 8. Claim 24: “The absorbent article of claim 1, wherein the fluid permeable top sheet is in contact with the first absorbent layer of the absorbent core at an area other than where the opening is located.” 108

9. Claim 25: “The absorbent article according to claim 1, wherein the fluid permeable topsheet is in contact with the fluid flow control structure via the opening, such that a cavity is formed along the longitudinal center line of the absorbent article.” ...110
- C. Ground III: Claim 7 Is Obvious Over Nakazawa-’190 in view of Glaug-’753 and Cohen-’429 111
 1. Claim 7: “The absorbent article according to claim 4, wherein the average size of the apertures in the first perforated polymeric layer is 0.5-5 mm” 111
- D. Ground IV: Claims 1-5, 7-8, 21-22, and 24-25 Are Obvious Over Nakazawa-’190 in view of Ponomarenko-’236 114
 1. Claim 1 114
 - a. 1[h]: “said fluid flow control structure being a layered structure comprising a non-perforated fibrous polymeric layer and a first perforated polymeric layer” 114
 2. Claim 2: “The absorbent article of claim 1, wherein the first perforated polymeric layer has a basis weight of from 60 g/m² to 100 g/m².” 121
 3. Claim 3: “The absorbent article of claim 1, wherein the first perforated polymeric layer is a nonwoven, a film or a film/nonwoven laminate” 122
 4. Claim 4: “The absorbent article of claim 1, wherein the first perforated polymeric layer is a three-dimensionally formed layer having penetrating apertures extending from a first surface of the first perforated layer towards a second surface of the first perforated layer and forming protrusions on said second surface” 123
 5. Claim 5: “The absorbent article according to claim 4, wherein the first perforated polymeric layer is arranged with said second surface facing the non-perforated fibrous polymeric layer.” ..126
 6. Claim 7: “The absorbent article according to claim 4, wherein the average size of the apertures in the first perforated polymeric layer is 0.5-5 mm” 127
 7. Claim 8: “The absorbent article according to claim 1, wherein open areas of the first perforated polymeric layer comprise 5-30% of the first perforated polymeric layers” 129

E.	Ground V: Claims 1, 3-5, 21-22, and 24-25 Are Anticipated By Nakazawa-'190.....	130
1.	Claim 1[h]: “said fluid control structure being a layered structure comprising a non-perforated fibrous polymeric layer and a first perforated polymeric layer”	131
2.	Claim 3: “The absorbent article of claim 1, wherein the first perforated polymeric layer is a nonwoven, a film or a film/nonwoven laminate”	133
3.	Claim 4: “The absorbent article of claim 1, wherein the first perforated polymeric layer is a three-dimensionally formed layer having penetrating apertures extending from a first surface of the first perforated layer towards a second surface of the first perforated layer and forming protrusions on said second surface”	133
4.	Claim 5: “The absorbent article according to claim 4, wherein the first perforated polymeric layer is arranged with said second surface facing the non-perforated fibrous polymeric layer” ...	134
XI.	AVAILABILITY FOR CROSS-EXAMINATION	135
XII.	RIGHT TO SUPPLEMENT	136
XIII.	JURAT	137

I. INTRODUCTION

1. My name is Behnam Pourdeyhimi. I am the William A. Klapman Distinguished Professor of Textile Materials in the Department of Textile Engineering at North Carolina State University. I am also the Associate Dean for Industry, Research, and Extension at the Wilson College of Textiles and the Executive Director of the Nonwovens Institute at North Carolina State University.

2. I have been retained as an expert in this proceeding by First Quality Retail Services, LLC, First Quality Consumer Products, LLC, First Quality Products, LLC and First Quality Enterprises, LLC (collectively, “First Quality” or “Petitioners”). I have been asked for my opinions regarding the validity of claims 1-5, 7-8, 20-22 and 24-25 of U.S. Patent No. 9,308,138 (the “’138 patent”) (EX1001-USP138). For the reasons set forth below, it is my conclusion that claims 1-5, 7-8, 20-22 and 24-25 are invalid.

II. QUALIFICATIONS AND EXPERIENCE

3. My curriculum vitae, which describes my education, experience, professional activities, and which lists, *inter alia*, my publications and patents, is attached as **Appendix A**. Below is a summary of my education, work experience, and other qualifications.

4. I received a Bachelor’s of Textiles from The University of Huddersfield in 1978 and a Doctor of Philosophy from the University of Leeds in Textiles in 1982.

5. Following my Ph.D., I was a research associate in the Department of Textile Materials and Management at North Carolina State University from 1982-1983. I was a research associate in the Department of Design and Environmental Analysis at Cornell University from 1983 to 1984. Following that, I joined the faculty at the University of Maryland as an Assistant and then an Associate Professor, in the Department of Textiles and Consumer Economics from 1984 to 1992. From 1992 to 1994, I was the Program Director in the Department of Textiles and Consumer Economics at the University of Maryland. From 1992 to 1995, I was an Associate Professor in the Department of Materials and Nuclear Engineering at the University of Maryland.

6. From 1995 to 1999, I was a professor in the School of Textile and Fiber Engineering at Georgia Tech. In 1999, I joined NC State as a Professor of Textile Technology and the Co-director of the Nonwovens Cooperative Research Center (NCRC).

7. In 2007, I established the Nonwovens Institute (NWI) which took over the activities of NCRC and expanded the focus of the activities to include other pillars including product development and innovation. NWI is supported by its consortium of members companies including raw material suppliers, nonwovens producers, machinery makers and downstream converters such as P&G and Kimberly Clark who produce hygiene products.

8. I have built over the last 25 years the most advanced pilot facilities for the production of materials such as acquisition distribution layers, absorbent cores, and other materials used in hygiene products, as well as those used in other market segments utilizing nonwoven structures. I have over the years offered advice, and guidance to many of the leading corporations in the world and have offered various training forums encompassing all aspects of nonwoven manufacturing as well as products. Market and patent intelligence is another activity that was designed to help assess the state of the art being practiced in various products and the market and technology drivers for growth.

9. I have received numerous awards; the most recent and significant ones include being inducted into the National Academy of Inventors, receiving the highest faculty award from both NC State (The Holladay Medal for Excellence) and the University of North Carolina System (The O'Max Gadner Award). The O'Max Gadner award is given to "that member of the faculty of ... The University of North Carolina, who, during the current scholastic year, has made the greatest contribution to the welfare of the human race." I received this award for my contributions to the field of nonwovens and in particular filtration and barrier materials utilizing nonwovens.

10. I have trained over 100 Masters and Doctoral students, and over 90% of those students hold key positions in industry today working for companies such

as P&G, Kimberly Clark, 3M, ExxonMobil, and other leading nonwoven producers including the top two companies in the World (Berry Global and Freudenberg). The technical director at Berry is one of my mentees and the entire R&D team at Freudenberg in Durham, NC are former students of mine.

11. The outcome of my research activities has resulted in 3 books, over 380 scholarly peer reviewed articles as well as over 200 presentations at various conferences. I hold 27 US patents, and over 50 international patents and currently have a number of US patent applications pending. I have also developed computer algorithms for the modeling of performance and analysis of nonwovens. I am considered an authority in the field of fibers, nonwovens and related products and have helped develop some key technological advancements in these fields.

III. LEGAL PRINCIPALS

12. I am not an attorney. For the purposes of this declaration, I have been informed about certain aspects of the law that are relevant to my opinions. My understanding of the law was provided to me by Petitioners' attorneys.

A. Scope of Opinion

13. I have been informed and understand that the petitioner in an *inter partes* review may request cancellation of claims as unpatentable only on grounds that such claims are anticipated or would have been obvious to a person of ordinary skill in the art at the time of the purported invention and only on the basis of prior

art consisting of patents or printed publications. My opinions in this declaration are limited to this scope.

B. Anticipation

14. I understand that to anticipate a claim of a patent, a prior art reference must disclose, either expressly or inherently, all limitations of a claim as those limitations are arranged in the claim.

C. Obviousness

15. I understand that a claim is unpatentable if it would have been obvious to a person of ordinary skill in the art at the time the alleged invention was made. I understand that a claim could have been obvious based on the teachings or suggestions of a single prior art reference or from a combination of two or more prior art references. I understand that an obviousness analysis requires an understanding of the scope and content of the prior art, any differences between the alleged invention and the prior art, and the level of ordinary skill in evaluating the pertinent art.

16. I further understand that a claim would have been obvious if it unites old elements with no change to their respective functions or alters prior art by mere substitution of one element for another known in the field, and that combination yields predictable results. Also, I understand that obviousness does not require physical combination/bodily incorporation, but rather consideration of what the

combined teachings would have suggested to persons of ordinary skill in the art at the time of the alleged invention.

17. In connection with obviousness, I have been informed that there must have been some reason or motivation that would have led a person of ordinary skill in the art to combine or modify the relevant teachings in the prior art to obtain the claimed invention, and one of ordinary skill in the art must have had a reasonable expectation of success in doing so.

18. While it may be helpful to identify a reason for this combination, I understand that there is no rigid requirement of finding an express teaching, suggestion, or motivation to combine within the references. If a person of ordinary skill in the art can implement a predictable variation, obviousness likely bars its patentability. For the same reason, 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. I understand that a claim would have been obvious if a person of ordinary skill in the art would have had reason to combine multiple prior art references or add missing features to reproduce the alleged invention recited in the claims.

19. I understand that a determination of whether a claim would have been obvious is based on a variety of considerations, including, among others:

- whether the teachings of the prior art references disclose known concepts combined in familiar ways, which, when combined, would yield predictable results;
- whether a person having ordinary skill in the art could implement a predictable variation, and would see the benefit of doing so;
- whether the claimed elements represent one of a limited number of known design choices, and would have a reasonable expectation of success by those skilled in the art;
- whether there is some teaching or suggestion in the prior art to make the modification or combination of elements claimed in the patent; and
- whether the alleged invention applies a known technique that had been used to improve a similar device or method in a similar way.

20. I also understand that in considering obviousness, it is important not to determine obviousness using the benefit of hindsight derived from the patent being considered. I also understand that one of ordinary skill in the art has ordinary creativity and is not an automaton.

21. I further understand that certain factors, commonly referred to as secondary considerations, may support or rebut the obviousness of a claim. I also understand that secondary considerations cannot be used to overcome anticipation. I understand that such secondary considerations include, among other things,

commercial success of the patented invention, skepticism of those having ordinary skill in the art at the time of invention, unexpected results of the invention, any long-felt but unsolved need in the art that was satisfied by the alleged invention, the failure of others to make the alleged invention, praise of the alleged invention by those having ordinary skill in the art, and copying of the alleged invention by others in the field. I understand that there must be a nexus, that is, a connection, between any such secondary considerations and the alleged invention. I also understand that contemporaneous and independent invention by others is a secondary consideration tending to show obviousness.

22. I reserve the right to respond to any allegations that may be put forth by Patent Owner in this proceeding that any secondary considerations tend to rebut the obviousness of any claim of the '138 patent discussed in this Declaration.

D. Claim Dependency

23. I understand that a patent may include two types of claims, independent claims and dependent claims. An independent claim stands alone and includes only the limitations it recites. A dependent claim can depend from an independent claim or another dependent claim. I understand that a dependent claim includes all the limitations that it recites in addition to all of the limitations recited in the claim or claims from which it depends.

24. The analysis in this declaration is in accordance with the above-stated legal principles.

IV. MATERIALS CONSIDERED

25. In preparing this declaration, I reviewed and considered the materials identified in **Appendix B** as well as any document cited in this declaration.

V. LEVEL OF ORDINARY SKILL IN THE ART

26. It is my understanding that when considering the claims of the '138 patent and the prior art, I must do so based on the perspective of one of ordinary skill in the art at the effective filing date of the '138 patent, which I understand is June 28, 2011, as that is when the '138 patent was filed as an international application. EX1001-USP138, Cover. For purposes of my analysis, I have considered the level of ordinary skill in the art as of June 2011.

27. I understand that several factors are to be considered in determining who would be a person of ordinary skill in the art. The factors include: (1) the types of problems encountered in the art; (2) the prior art solutions to those problems; (3) the rapidity with which innovations are made; (4) the sophistication of the technology; and (5) the educational level of active workers in the field.

28. Based on these factors as well as my experience and expertise, a person of ordinary skill in the art at the relevant times, would have had (1) a degree or certificate in nonwoven science and engineering, fiber and polymer science, textile

engineering, chemical engineering, chemistry, paper engineering, mechanical engineering, biology or a related field; and (2) two to four years of work experience in product design and testing of disposable absorbent articles, such as diapers, sanitary napkins and incontinence pads. Less work experience may be compensated by a higher level of education, and vice versa.

VI. OVERVIEW OF THE TECHNOLOGY

A. Design Constraints and Challenges of Absorbent Articles

29. Absorbent articles for collecting human bodily fluids have been known and sold for many decades. *See generally*, EX1018-White2018. These absorbent articles include disposable infant diapers, feminine sanitary napkins, and adult incontinence pads. *See, e.g.*, EX1004-Bergstrom-'059, 1:10-12 (“disposable absorbent articles such as diapers, sanitary napkins, incontinence guards and panty liners are used to absorb and manage bodily exudates such as urine, menses or faeces.”); EX1005-Kim-'837, 1:12-16 (“[a]n article such as a sanitary napkin, a panty liner and a pad for incontinence of urinary (hereinafter, referred to as ‘absorbent article’), which absorbs and retains bodily fluid discharged from a wearer’s body, is widely known in personal sanitary art.”); EX1006-Glaug-'753, 1:11-14 (“disposable absorbent articles, e.g., diapers, catamenial pads, panty liners, shields, etc., frequently make use of a liquid absorbent core located between a top-sheet and a back sheet”); EX1008-Nakazawa-'190, [0002] (“[a]bsorbent articles are

used in disposable diapers (for example, tape-style diapers, pants-style diapers, urine pads, etc.) that absorb excretory fluids such as urine, sanitary napkins that absorb menstrual blood, and vaginal discharge sheets that absorb vaginal discharge.”); EX1009-White2003, 243 (“The disposable absorbent hygiene products business sector covers products for baby care, feminine hygiene and adult incontinence management. . . . These products are all linked by the same basic requirement that they have to first and foremost be absorbent structures.”); EX1011-Gupta2002, 372 (“the major absorbent structures considered are disposable infant diaper, feminine sanitary napkin, underpad, adult incontinence pad, wound dressing (primary and secondary), absorbent wipe and oil absorbent”); EX1017-Wieseman2011, 316 (“the most commonly used absorbent products for personal health and hygiene are baby diapers, adult incontinence products, and feminine hygiene products”). The chart below summarizes a number of these articles:

Table 5.1 Market segments and products falling under the heading of NHMs

Diapers	Feminine hygiene	Adult incontinence
Baby diapers Nappies Training pants	Sanitary napkins Feminine pads Sanitary towels Panty liners Panty shields Tampons	Adult diapers Briefs Insert pad and pant Bladder control pads Undergarments Guards Shields Panty liners Underwear Underpads Bed pads

EX1010-Ajmeri2010, Table 5.1, p. 90; *see also* EX1018-White, 44.1.

30. These articles are constrained both in size and width to be able to fit between a user's legs without impeding a user's movement and without compromising fluid absorption capabilities of the article itself. EX1010-Ajmeri2010, 86 ("In addition to high productivity and low cost, one of the key aims in designing hygiene materials is to reduce the size or weight without compromising the fluid holding capacity.").

31. These design constraints pose several challenges and considerations when designing an absorbent product.

32. *First*, the article must be able to distribute fluid rapidly and evenly to different parts of the absorbent layers without any fluid or waste leaking out of the article. EX1005-Kim-'837, 1:37-50 (describing the need for an absorbent article to

distribute rapidly (i.e., spread velocity) fluid to avoid leakage and the sensation of wetness by the wearer). When excretory fluid is absorbed from the topsheet side of the absorbent material, “tends to be unevenly distributed in the top surface side of the absorbent material in the thickness direction.” EX1008-Nakazawa-’190, [0005]. Therefore, when the wearer exerts pressure, excretory fluid tends to flow back from the topsheet side, causing not only discomfort but also irritation and other problems. *Id.*

33. *Second*, the absorbent article, and specifically the absorbent layers in the article, must have sufficient capacity to absorb *all of the fluid* that is expected to be released during the period of wear. EX1010-Ajmeri2010, 86; EX1006-Glaug-’753, 2:41-48. The article must also be able to withstand multiple insults of body fluids during wear. EX1006-Glaug-’753, 2:41-48. The necessary capacity may vary depending on the absorbent article’s function (e.g., heavy or light adult incontinence pad vs. sanitary napkin). EX1009-White2003, 243; *see also* EX1006-Glaug-’753, 1:50-52 (“The absorbent core of many disposable diapers and other higher performance incontinence products, e.g., adult briefs, typically have cores with enhanced absorbency capability.”); EX1017-Wieseman2011, 319 (“Users of baby diapers, adult incontinence products, and feminine hygiene products all require a product that facilitates cleanliness by absorbing and retaining fluid . . . and does not leak.”). It is desirable for the absorbent article to include materials that reduce

the size or weight without compromising the fluid holding capacity. EX1010-Ajmeri2010, 86.

34. *Third*, the absorbent article must be able to absorb fluid at the *speed it is delivered*. Thus, it is desirable for the absorbent article to receive and contain the emitted fluid with corresponding speed. EX1010-Ajmeri2010, 86 (“These [important functions of an absorbent hygiene material] are to receive fluid, imbibe it rapidly, hold it for a period of time. . . .”); EX1008-Nakazawa-’190, [0004](“when the rate of excretion exceeds the absorption rate of the absorbent material, or when a large amount of excretory fluid is excreted all at once, the excretory fluid flows over the top sheet. In such cases, the unabsorbed excretory fluid that flows over the top sheet covers a large area of the wearer's skin, causing not only an unpleasant sensation but also a rash.”). It is important that the article be able to “receive fluid, imbibe it rapidly.” EX1010-Ajmeri2010, 86. In the circumstance where the “rate of excretion exceeds the absorption rate of the absorbent material, or when a large amount of excretory fluid is excreted all at once, the excretory fluid flows over the top sheet.” EX1008-Nakazawa-’190, [0004]. “In such cases, the unabsorbed excretory fluid that flows over the top sheet covers a large area of the wearer’s skin, causing not only unpleasant sensation but can also cause a rash.” *Id.* “Excretory fluid that flows over the top sheet can also leak from the absorbent article.” *Id.*

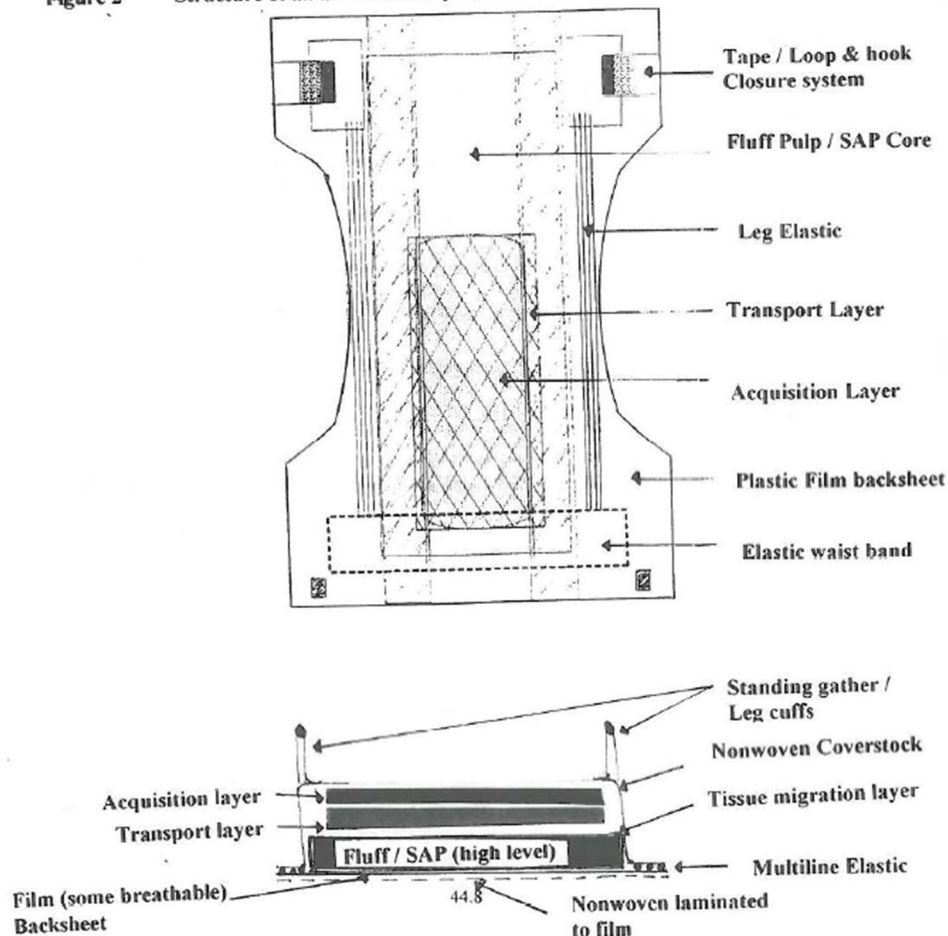
35. *Fourth*, the absorbent article must be able to rapidly absorb fluid, while maintaining the dryness of the outer surfaces of the article, which face the wearer's skin and undergarments. EX1009-White2003, 246 ("Absorbent hygiene products have to fulfill a number of functions in order to be satisfactory in use, among these requirements are the following: 1. To keep the surface layer as dry as possible in order to promote good skin care conditions"); EX1010-Ajmeri2010, 86 ("The product is usually composed of a number of components, each supporting different but important functions" including to "keep the skin of the wearer dry"); EX1011-Gupta2002, 374 ("The function of the facing in this and similar absorbent products is to present a surface with the following characteristics: . . . Dryness; to maintain essentially a dry surface in contact with [the] skin."); EX1017-Wieseman2011, 319 ("Users of baby diapers, adult incontinence products, and feminine hygiene products all require a product that . . . protects the skin from damage due to exposure of excess moisture and digestive enzymes.").

36. The structure and design of absorbent articles have changed and evolved over the last several decades, but generally, absorbent structures as they existed before the filing date of the '138 patent included four primary elements: (1) one or more absorbent cores, (2) one or more fluid acquisition / distribution layer(s), (3) a fluid permeable topsheet and (4) a fluid impermeable backsheet. EX1011-Gupta2002-373; *see also* EX1009-White2003, 246 ("building blocks are made up

of: (a) a top sheet layer which can be a pre-formed non-woven carded fibre web, a continuous filament web or a plastic film with carefully designed holes; (b) an acquisition and transport layer, which may be non-woven, made of synthetic fibres or a modified cellulose fibre layer; (c) a wetlaid tissue wrap layer that surrounds the core; (d) a storage core layer that is made up of cellulose fluff pulp and superabsorbent polymers; (e) a backing containment layer that is normally a plastic film, which may be breathable.”). The basic format of an absorbent article has been known since the 1990s:

The basic format of the present day diaper was born.

Figure 2 Structure of an all-in-one diaper, circa 1998.



EX1018-White2000, Figure 2 (showing basic features of an all-in-one diaper, circa 1998); *see* EX1017-Wieseman2011, 317 (describing the common elements across all absorbent article products).

B. Absorbent Articles May Include Certain Well-Known Structures

1. Topsheet

37. The topsheet is the uppermost layer that contacts a user's skin. EX1011-Gupta2002, 376 ("The nonwoven fabric that is positioned next to the skin of the wearer of an absorbent sanitary product has been given various names, including: a) cover, b) coversheet, c) coverstock, d) facing, e) topsheet, and others. Despite this variety in descriptive terms, there is no uncertainty about the item involved; it is the soft, nonwoven fabric on the diaper surface that contacts the skin or body of the wearer."); EX1012-Kosemund2009, 82 ("The topsheet is the layer in direct contact with the skin. It consists of a soft nonwoven synthetic sheet, composed of polypropylene/polyethylene, either alone or as a blend.").

38. The topsheet (sometimes also referred to as the skin contact layer or facing layer) is typically made from a nonwoven fabric designed to be soft, hypoallergenic, and free from irritants to ensure comfort and prevent skin irritation. EX1011-Gupta2002, 374 ("The function of the facing [topsheet or nonwoven facing] in this and similar absorbent products is to present a surface with the following characteristics: Softness; pleasing tactile aesthetics, especially in contact

with sensitive skin. . . . Safety; inert or non-toxic surface for contact with skin . . . Dryness; to maintain essentially a dry surface in contact with skin.”); EX1012-Kosemund2009, 82 (“The topsheet is the layer in direct contact with the baby’s skin. It consists of a soft nonwoven synthetic sheet, composed of polypropylene/polyethylene, either alone or as a blend.”); *see also* EX1018-White2000, 44.13-44.15 (describing the “skin contact layer” e.g., the coverstock or topsheet or facing layer).

39. The topsheet is also designed to be permeable, allowing fluids to quickly pass through to the absorbent layers while keeping the surface dry. EX1011-Gupta2002, 374 (“The function of the facing [topsheet or nonwoven facing] in this and similar absorbent products is to present a surface with the following characteristics: . . . Fluid Permeability; to allow easy passage of fluid into absorbent reservoir . . . Dryness; to maintain essentially a dry surface in contact with skin.”); EX1012-Kosemund2009, 82 (“The main function of this layer is to transfer urine and other liquids quickly to the layers beneath.”). Many topsheets are treated so they have hydrophilic properties, enhancing their ability to wick moisture away from the skin; topsheets can also be treated with odor controlling agents to minimize unpleasant smells. EX1012 Kosemund2009, 82 (“In addition, the topsheet may carry a lotion to protect the skin from overhydration and irritation.”).

2. Backsheet

40. The backsheet is the outermost layer, i.e., furthest from the user's body, that is a protective barrier against leaks. EX1010-Ajmeri2010, 92-93 ("the back sheet is an impermeable thin film or barrier fabric that prevents leakage"); EX1011-Gupta2002, 374 ("The backing or back layer of the normal absorbent structure is usually an impervious film, most frequently made of low density polyethylene."); EX1012-Kosemund2009, 82 ("The backsheet is the water-resistant outer layer of the diaper, typically made of a polyethylene film laminated with a soft-textured, cloth-like polypropylene."); EX1017-Wieseman2011, 320-321 ("A backsheet prevents moisture in the core from exiting the pad and staining clothing. A backsheet may be completely impermeable or, as it is the case in most modern backsheets, semi-permeable ('breathable'), allowing water vapor but not liquid to pass"); *see also* EX1018-White2000, Figures 1 and 2.

41. The backsheet is typically made from thin, flexible, waterproof material, such as polyethylene or a breathable film, designed to prevent fluid from escaping the pad. EX1011-Gupta2002, 374 ("The backing or back layer of the normal absorbent structure is usually an impervious film"); EX1012-Kosemund2009, 82 ("The backsheet is the water-resistant outer layer of the diaper, typically made of a polyethylene film laminated with a soft-textured, cloth-like propypropylene. Its function is to prevent liquid from leaking out of the diaper into the outer clothing.").

42. The backsheet's structure is often reinforced with nonwoven fabrics to provide additional strength and comfort while maintaining a discreet profile. EX1010-Ajmeri2010, 92-93.

43. The backsheet performs a crucial role in maintaining the integrity of the pad, ensuring that fluids are contained and that the user's clothing and surroundings remain dry. EX1011-Gupta2002, 374 ("The obvious function of this component [i.e., backing or back layer] is to restrain the fluid within the pad, present a dry surface to the exterior of the product, and provide the user freedom of movement and feeling of comfort. The film may be breathable to add another dimension to the comfort.").

44. For some absorbent articles, the backsheet may also be coated with an adhesive so the article can be secured to a user's underwear, like incontinence pads and feminine hygiene products. EX1010-Ajmeri2010, 95 ("the product is fastened to the underwear by an adhesive strip on the backsheet"); EX1011-Gupta2002, 380 (describing "a pressure sensitive adhesive on the film backing for positioning and affixing the pad to the undergarment").

3. Absorbent Layers

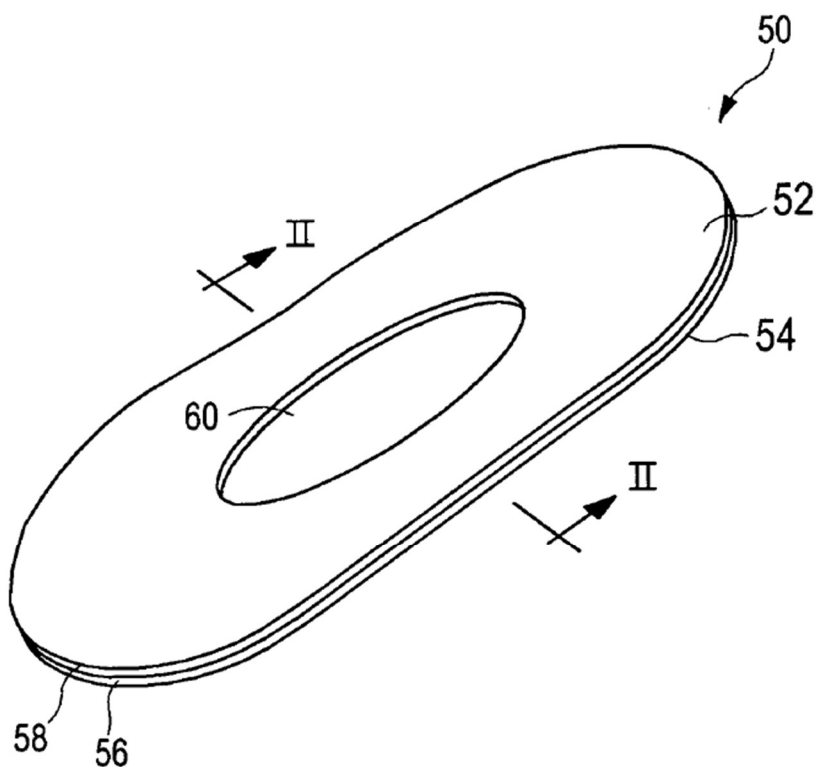
45. The absorbent layers, which can also be referred to as the absorbent cores, are the components responsible for capturing and retaining fluids. EX1010-Ajmeri2010, 92 ("The absorbent core is the heart of an absorbent hygiene

material.”); EX1012-Kosemund2009, 82. These layers typically consist of a blend of materials, including fluff pulp and superabsorbent polymers (“SAPs”) that can retain large amounts of fluid. EX1010-Ajmeri2010, 92 (“In modern diapers, the core consists of hydrophilic wood pulp and SAP.”); EX1012-Kosemund2009, 82 (“[The absorbent core] typically consists of a blend of polyacrylate granules blended with fluff cellulose pulp (bleached by an elemental chlorine-free process) and encapsulated by either a cellulose or polypropylene nonwoven layer. The cellulose portion of the core functions to quickly absorb and transfer urine to the polyacrylate superabsorber. The superabsorber is able to absorb urine and to lock it within its polymeric structure to keep it away from baby’s skin, even under pressure as when a baby sits on a full diaper.”); *see also* EX1018-White2000, 44.14-44.16.

46. Before the ’138 patent, it was known that absorbent articles could have multiple absorbent layers. EX1008-Nakazawa-’190, [0044] (“These liquid-absorbing materials are usually used as single or multi-layered mats. . . . The SAP may be uniformly mixed in each mat of fluff pulp, or it may be arranged as layers interposed between layers of fluff pulp.”).

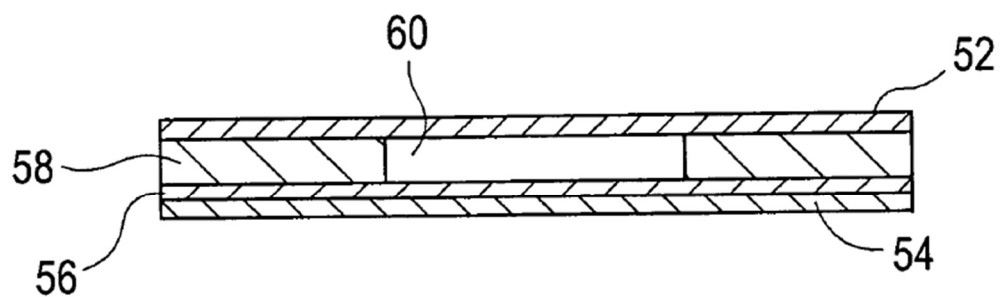
47. Before the ’138 patent, it was also known that absorbent articles may also have openings or channels within one or more absorbent core layers to enhance the absorbent article’s fluid management capabilities. *E.g.*, EX1005-Kim-’837, Figures 1 and 2 (Prior Art figures)

Figure 1



(PRIOR ART)

Figure 2

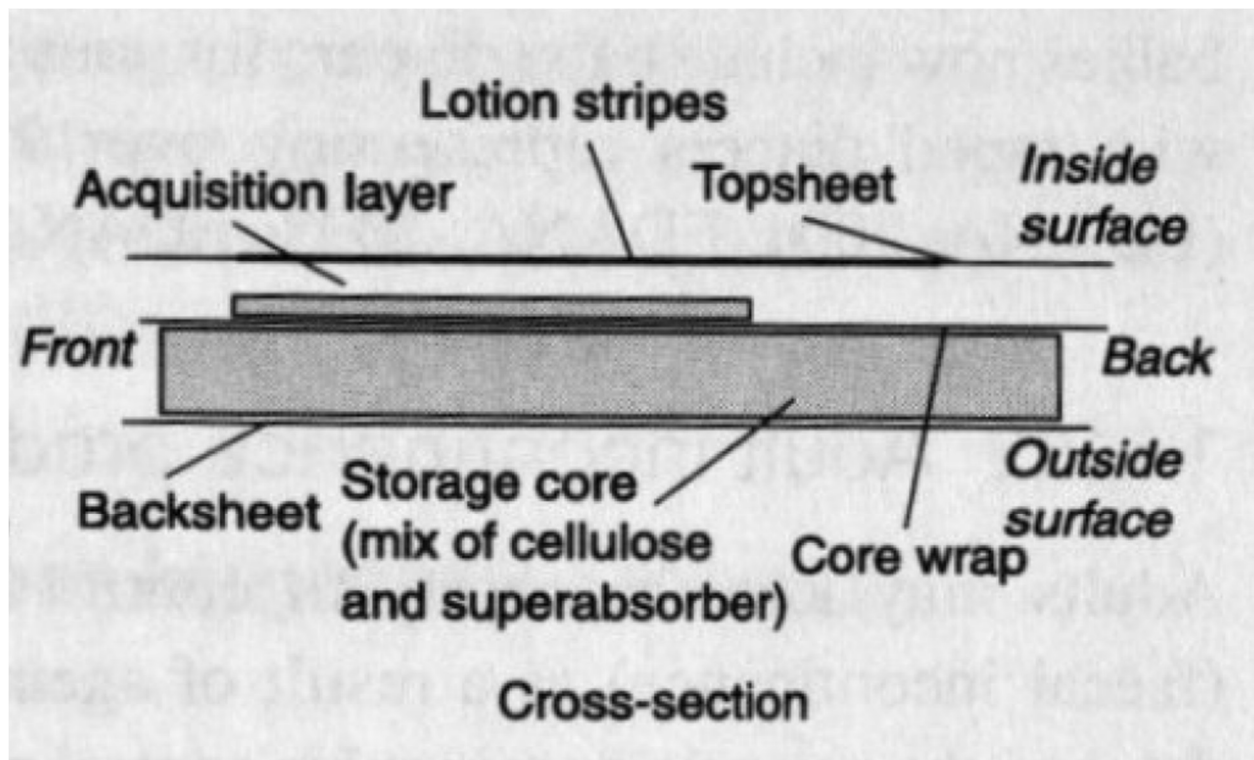


(PRIOR ART)

EX1004-Bergstrom-'050, 6:33-7:7 ("The upper absorbent core 20 comprises an opening 21, as shown in Figures 1-8. The opening 21 extends through the entire thickness of the upper absorbent core 20, from one face to the other (*see* Figure 4). The opening 21 may be introduced as part of the manufacturing process of the upper core 20, e.g., stamped or pressed out of the upper core 20, or formed in a mould as part of an airlaying process. The opening 21 is located in at least region 50, such that the opening 21 in the upper absorbent core 20 at least overlies both the acquisition layer 40 and the lower absorbent core 30"); EX1008-Nakazawa-'190, [0006]-[0007] ("Disposable diapers have been disclosed that have grooves formed in the longitudinal direction on the front and back surfaces of the absorbent material in order to provide excellent diffusion of excretory fluid in the longitudinal direction"). These openings help direct and distribute fluid more efficiently across the core. The openings quickly spread liquid away from the point of contact, reducing the likelihood of saturation in one area and preventing leaks. *E.g.*, EX1005-Kim-'837, Figures 1 and 2 (Prior Art figures); 1:42-48; EX1008-Nakazawa-'190, [0007]; EX1004-Bergstrom-'050, 6:33-7:7; *see also* EX1018-White2000, 44.6 ("The concept of flow spreading was not new. Johnson & Johnson had developed feminine hygiene products with channels by which the menstrual fluid could be quickly moved towards the ends of the pad.").

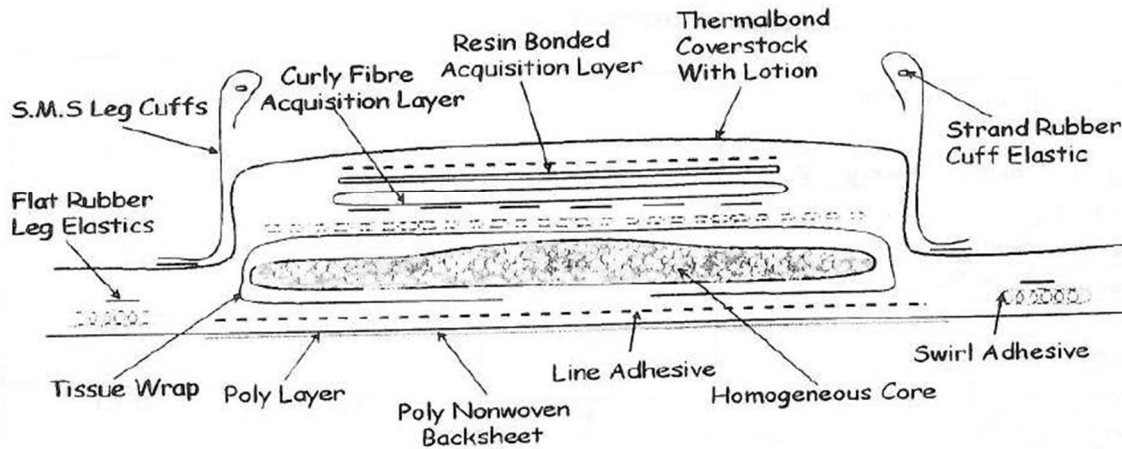
48. The openings can also promote more uniform absorption, distributing fluid to SAPs in a more even distribution throughout the absorbent core. Openings can also enhance comfort by keeping the surface drier and reducing bulkiness. EX1008-Nakazawa-'190 [0034] (“In the first absorbent article, the hole portions formed in the absorbent material are formed so that the opening in the hole portions has an elongated shape extending in the longitudinal direction of the absorbent material. In this way, the hole portions allow the absorbent material to bend and conform more closely to the wearer’s urination site, improving wearer fit.”).

49. Before the '138 patent, it was also known that absorbent layers may also include a core wrap that either fully or partially encloses the absorbent layer:



EX1017-Wieseman2011, Figure 14.1. The core wrap is also sometimes referred to as a “tissue wrap”:

Figure 3 Cross section of Diaper Type 1.



EX1018-White2000, Figure 3. The core wrap or tissue wrap prevents “migration” of the absorbent materials that make up the absorbent layer (e.g., the super absorbent polymer (SAP) and wood pulp fluff. EX1018-White2000, 44.15-44.16.)

4. Fluid Acquisition Layers

50. Fluid acquisition layers, which may also be referred to as an acquisition/distribution layer (ADL), diffusion sheet, or transfer layer, are included in absorbent articles and are positioned at some layer between the topsheet and backsheet. These layers help quickly acquire and evenly distribute fluids across the absorbent core, preventing leaks and ensuring the absorbent article’s effectiveness. EX1010-Ajmeri2010, 92 (“The mechanism of enhancement of liquid movement has been further advanced by the use of an acquisition/distribution layer (ADL) between

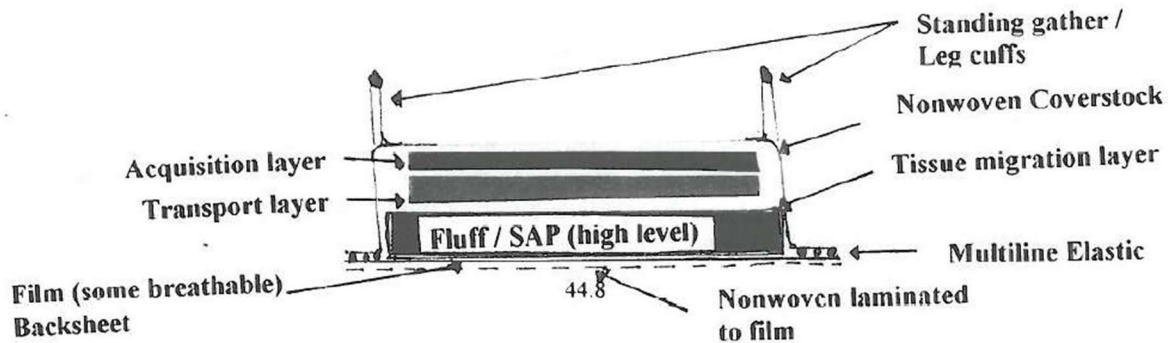
the topsheet and the absorbent core. The ADL provides for more rapid liquid acquisition (minimizing flooding in the target zone), and more rapid transport and thorough distribution of the fluid into the remainder of the absorbent region.”); EX1011-Gupta2002, 374 (“In some structures . . . an intermediate layer (transition layer) is encountered behind the facing. This tissue is utilized to enhance flow of fluid away from the backside of the facing, transport fluid along its plane, and increase the volume of the pulp pad involved in absorbing fluid.”); EX1012-Kosemund2009, 82 (“the acquisition/distribution layer is usually composed of modified cellulose patch and a polyester-based layer sandwiched between the topsheet and the core, which is not in direct contact with the skin. Its main function is to facilitate movement of liquid away from the baby and to distribute it evenly across the entire diaper core for efficient and maximal absorbency”); EX1004-Bergstron-’059, 9:27-30 (stating that “[t]he acquisition layer 40 acts to receive liquid rapidly, to temporarily hold it and to distribute it evenly to the upper and lower absorbent cores” and “that [a] forming element 60 is preferably located between the acquisition layer 40 and the lower absorbent core 30 and helps promote “[l]iquid flow towards the ends of the core.”); EX1008-Nakzawa-’190, [0061] (“The diffusion sheet used in the first absorbent article . . . is disposed on the back surface of the absorbent material. This diffusion sheet has higher liquid permeability than the absorbent material, and when excretory fluid flows into the hole portions of the

absorbent material, it can permeate the diffusion sheet and diffuse faster than it can be absorbed by the absorbent material.”); EX1006-Glaug-’753 at 9:40-46 (“the fluid acquisition system 34 . . . optimizes the fluid penetration rate and volume into the absorbent core 36 below it, while also minimizing the fluid from exiting the diaper.”); EX1007-Ponomarenko-’236, 6:39-40 (“[T]he sublayer (30) herein comprises or is one or more acquisition layers (e.g., that can temporarily absorb fluids, like urine and pass on or transport the fluid to the absorbent core that is in proximity to said sublayer 30.”).

51. By rapidly moving fluid away from the topsheet, the ADL minimizes the time the liquid is in contact with the skin, helping to maintain dryness and comfort. EX1012-Kosemund2009, 82. Additionally, by evenly spreading the fluid throughout the absorbent core, the ADL maximizes the core’s capacity, preventing saturation in one area and reducing risk of leaks. EX1011-Gupta2002, 374; *see also* EX1012-Kosemund2009, 82 (“The acquisition/distribution layer is usually composed of a modified cellulose patch and a polyester-based layer sandwiched between the topsheet and the core, which is not in direct contact with the skin. Its main function is to facilitate the movement of liquid away from the baby and to distribute it more evenly across the entire diaper core for efficient and maximal absorbency.”); EX1006-Glaug-753, 2:16-20 (“In particular, an acquisition layer improves ‘wicking’ of the absorbent article by spreading the body fluid in the ‘x’

and ‘y’ plane over the area of the core encompassed by the acquisition layer while also carrying the fluid in the ‘z’ direction to the core.”); EX1018-White2000, 44.6 (describing Kimberly-Clark’s development of “the concept of a high-tech flow spreading layer which would quickly move urine to distant parts of the core to be absorbed before leakage could take place.”)

52. Fluid acquisition systems were known to sometimes have more than one layer. For example, White2000 describes a two layer “Acquisition/Transport” structure:



EX1018-White2000, Figure 2. White2000 describes the acquisition layer of this structure to be predominantly hydrophilic” As White2000 explains “[t]he fluid that is instantaneously transferred through the top sheet must be absorbed as quickly by capillary forces in the acquisition layer. . . . For a wicking or transport layer, the important characteristics are wettability, pore size and pore distribution.” EX1018-White2000, 44.14. Glaug-’753 explains that this top “fluid acquisition layer” may be formed of materials such as an “apertured polymeric, e.g., three dimensional, film”

and that this “second fluid acquisition layer” (e.g., the transport layer) may be comprised of materials such as a fibrous (e.g., porous but nonperforated) material.

EX1006-Glaug-’753, Abstract, 3:54-4:4; *see also id.*, Figure 2:

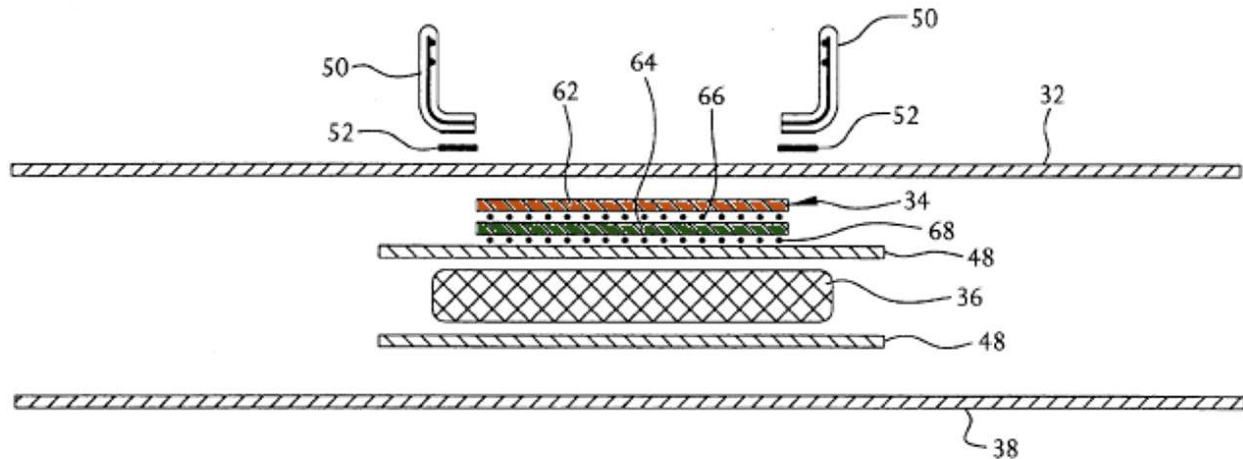


FIG. 2

VII. OVERVIEW OF THE '138 PATENT

A. Overview

53. The '138 patent states in its Abstract that the invention relates to “[a]n absorbent article including a fluid permeable topsheet, a fluid impermeable backsheet and an absorbent core enclosed between the topsheet and the backsheet.”

EX1001-USP138, Abstract.

54. Figures 1 and 2 show an “incontinence protector” (e.g., an absorbent article) “seen from the side which will be facing the undergarment when the incontinence protector is being worn.” EX1001-USP138, 10:12-15, 33-36.

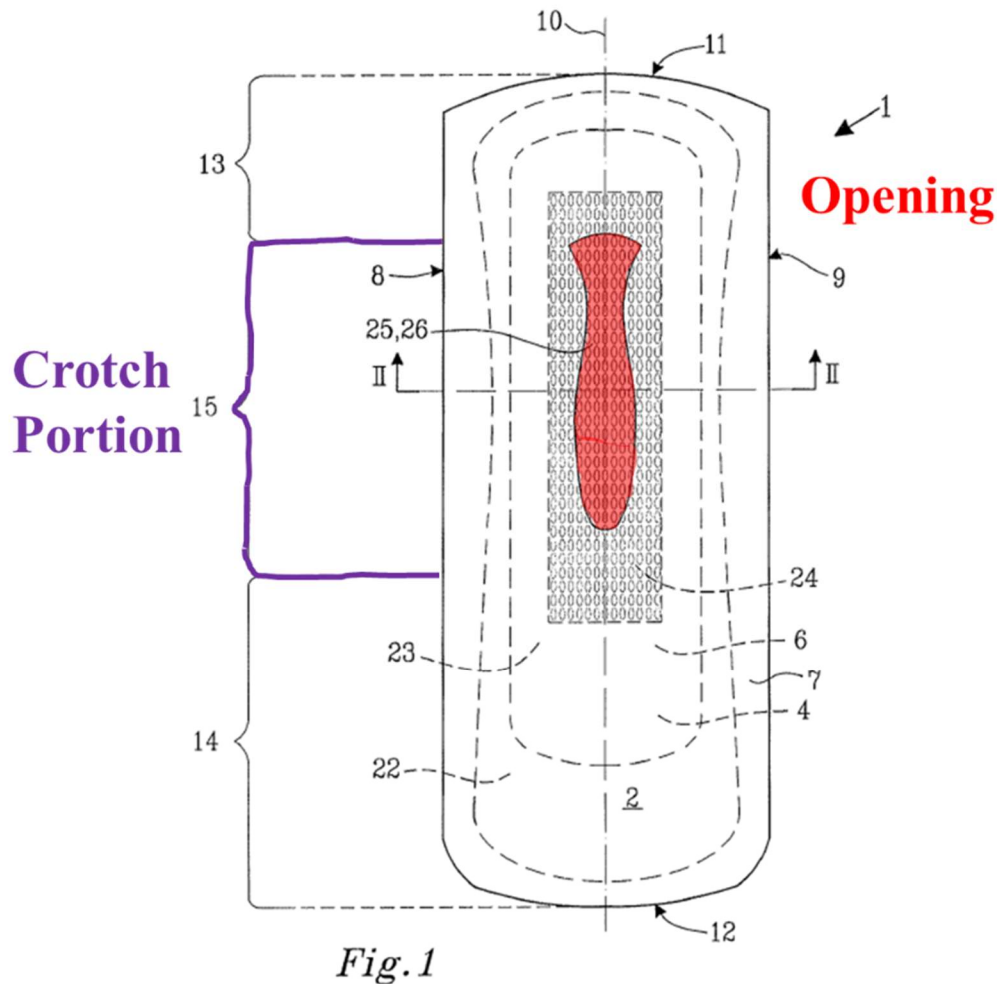


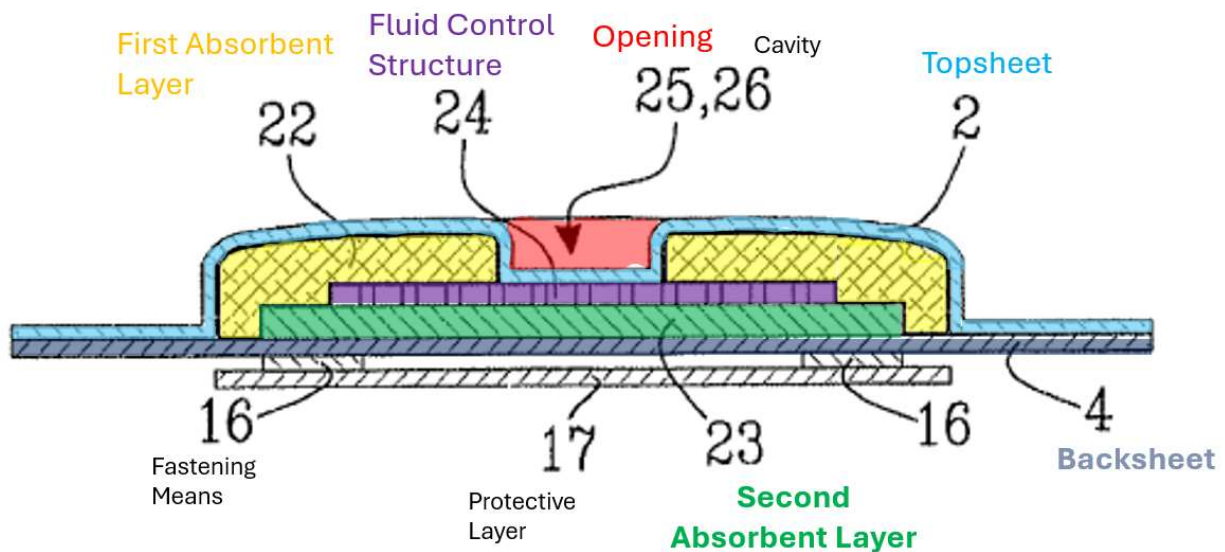
Fig. 1

EX1001-USP138, Figure 1.

55. The '138 patent explains that the incontinence protector includes a fluid permeable topsheet 2, a backsheet 4, and an absorbent core 6 enclosed between the topsheet 2 and the backsheet 4. EX1001-USP138, 10:37-39. The '138 patent also explains that the absorbent core 6 includes a first absorbent layer 22 and a second absorbent layer 23, with a multi-layered fluid flow control structure 24 between. EX1001-USP138, 11:34-36. The '138 patent also explains that the first absorbent layer 22 has an opening 25 extending completely through layer 22 in the crotch

portion of the incontinence protector. *Id.* at 11:52-54. The '138 patent also explains that the opening 25 has an elongate shape and is located along a center longitudinal line of the article. *Id.*, Figure 1, 11:54-57. The '138 patent also describes a fluid flow control structure that is preferably made of three layers but can also be made of at least two layers: a perforated polymeric layer and a non-perforated fibrous layer. EX1001-USP138, claim 1, 12:27-31.

56. Figure 2 of the '138 patent depicts a cross section through the incontinence protector (e.g., absorbent article). EX1001-USP138, 10:16-17:



EX1001-USP138, Figure 2.

B. Examination of the '138 Patent Before the United States Patent and Trademark Office

57. I have reviewed certain portions of the record of the '138 patent application as the Patent Owner was trying to get the patent granted from the U.S. Patent and Trademark Office.

58. I understand that the application for the '138 patent was filed internationally on June 28, 2011, and was filed in the United States on December 26, 2013. EX1003-USP138, Cover. For the purposes of my analyses, I assumed that June 28, 2011 is the priority date, or effective filing date, of the patent. During prosecution of the '138 patent, the Examiner rejected the pending claims six times based on at least four different prior art references. EX1003-USP138, 711-19 [Non-Final Rejection dated Mar. 25, 2014], 749-57 [Final Rejection dated Jul. 11, 2014], 798-806 [Non-Final Rejection dated Oct. 23, 2014], 1003-1012 [Final Rejection dated Mar. 5, 2015], 1063-1075 [Non-Final Rejection dated Jun. 29, 2015], 1280-1293 [Final Rejection dated Sep. 11, 2015] In response to each reference, the Applicant made a number of claim amendments to overcome these rejections. EX1003-USP138FH, 733 [Office Action Response dated Jun. 24, 2014, page 2], 781 [Office Action Response dated Oct. 6, 2014, page 2], 849 [Office Action Response dated Feb. 6, 2015, page 2], 1037 [Office Action Response dated Apr. 29, 2015, page 2], 1301-02 [Office Action Response dated Nov. 20, 2015, page 2-3]. Below,

I have annotated claim 1 of '138 patent with the various amendments that were made in response to each rejection:

Claim 1 (Currently Amended): An absorbent article having a longitudinal direction and a transverse direction, side edges extending in the longitudinal direction and end edges extending in the transverse direction and comprising:

a fluid permeable topsheet,

a fluid impermeable backsheet, and

an absorbent core enclosed between said topsheet and said backsheet, said absorbent core comprising,

a first absorbent layer having an opening ~~extending therethrough~~ that passes through the first absorbent layer from one major surface to an opposing major surface and therebetween the opening is surrounded by a closed periphery of the first absorbent layer,

a fluid flow control structure, and

a second absorbent layer arranged between the fluid flow control structure and the fluid impermeable backsheet,

wherein the fluid flow control structure is arranged between said first absorbent layer and said backsheet, said fluid flow control structure being a layered structure comprising a non-perforated fibrous polymeric layer and a first perforated polymeric layer, and

~~wherein the polymers in the first perforated polymeric layer are selected from polyolefins, polyesters, polyamides and blends and combinations thereof, and the first perforated polymeric layer has a basis weight from 50 g/m² to 150 g/m² the opening extends along a longitudinal center line of the absorbent article, the longitudinal center line being in parallel with the longitudinal direction of the absorbent article, and the fluid permeable top sheet is in direct contact with the fluid flow control structure via the opening.~~

EX1003-USP138FH, 733 [Office Action Response dated Jun. 24, 2014, page 2], 781 [Office Action Response dated Oct. 6, 2014, page 2], 849 [Office Action Response dated Feb. 6, 2015, page 2], 1037 [Office Action Response dated Apr. 29, 2015, page 2], 1301-02 [Office Action Response dated Nov. 20, 2015, page 2-3].

59. Of note, in the Examiner's last rejection prior to the patent application being allowed, the Examiner found that one of the references discussed in this declaration, Glaug-'753, "teaches a layered fluid control structure that comprises a non-perforated fibrous polymeric layer and a first perforated polymeric layer" that "serves to facilitate the transference of fluid into the core at a rate in which the materials can accommodate thereby preventing undesirable leakage as taught by Glaug." EX1003-USP138FH, 1284-85 [Final Rejection dated Sep. 11, 2015, page

4-5]. The Patent Owner *did not* dispute the Examiner's statement that Glaug-'753 taught the claimed fluid control structure. Instead, it amended the claim above with the language that is highlighted in blue. EX1003-USP138FH, [Office Action Response dated Nov. 20, 2015, page 2-3].

60. After the Applicant made this amendment to claim 1, the Examiner allowed the claims by issuing a Notice of Allowance on December 22, 2015. EX1003-USP138FH, 1358-64 [Notice of Allowance dated December 11, 2015]. In the Notice of Allowance, the Examiner stated that "[t]he closest prior art of record is US Patent 7,850,672 to Guidotti et al. While Guidotti et al. disclose an absorbent article including first and second absorbent layers wherein the first absorbent layer has an opening that passes through the absorbent layer as claimed, Guidotti et al. fail to teach or fairly suggest a layered fluid control structure comprising a non-perforated and perforated polymeric layer in combination with the opening extending along a longitudinal center line of the absorbent article." EX1003-USP138FH, 1363 [Notice of Allowance dated December 11, 2015, page 2].

61. The prior art that I rely on in forming my opinions that the challenged claims are invalid, with the exception of Glaug-'753, was not before the Patent Office during examination of the '138 patent. Nakazawa-'190 was cited on the face of the '138 patent, but I understand a full English translation of Nakazawa-'190 was not provided to the Patent Office.

VIII. OVERVIEW OF THE ASSERTED PRIOR ART

A. Bergstrom-'059

62. Bergstrom-'059 shows an absorbent article including a topsheet, a backsheet, and an absorbent core that has both an upper absorbent layer and a lower absorbent layer. EX1004-Bergstrom-'059, Abstract, 2:9-11. Bergstrom-'059 states that in certain versions of its absorbent article, an acquisition layer and a forming element are located between the upper and lower absorbent layers. EX1004-Bergstrom-'059, Abstract, 2:15-17. Bergstrom-'059 states that the upper absorbent layer has an opening at its center. EX1004-Bergstrom-'050, Abstract, 2:17-19, 31-32.

63. Figure 4, reproduced below, depicts an exploded three-dimensional view of an absorbent article as described by Bergstrom-'059.

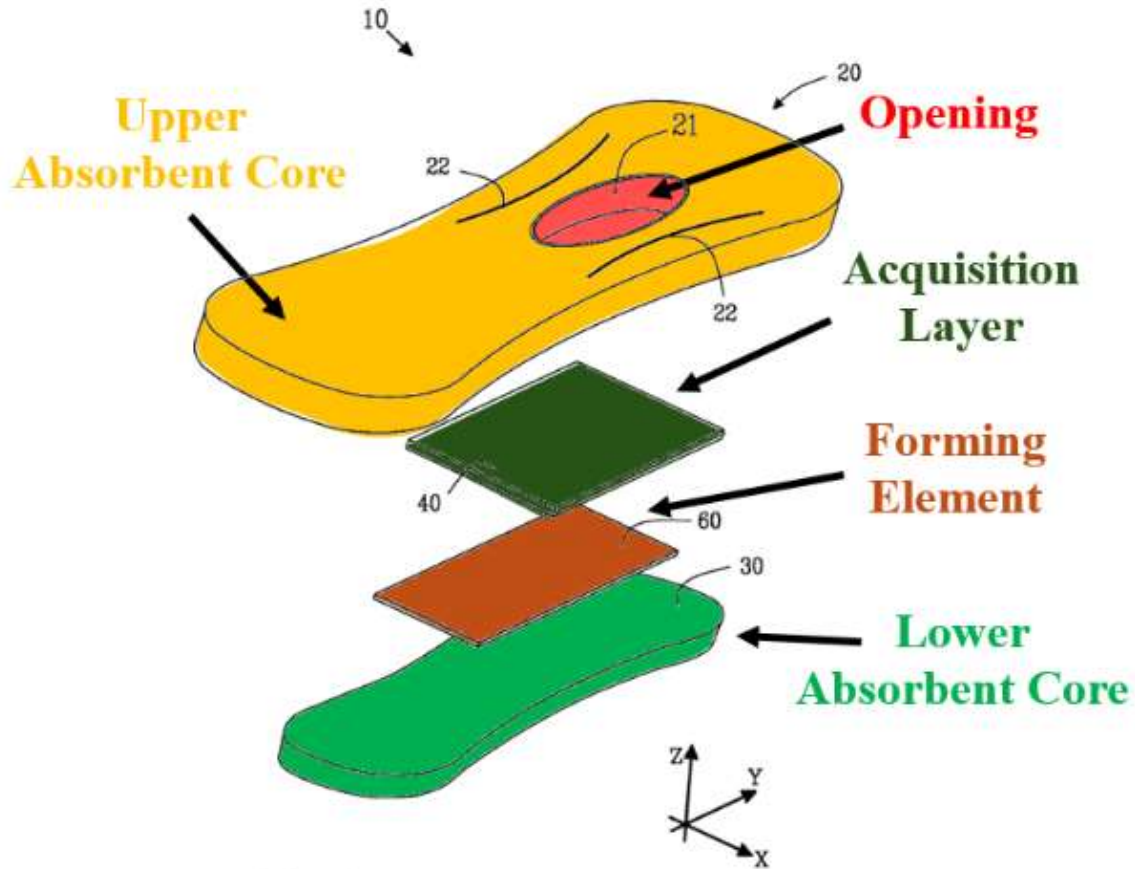


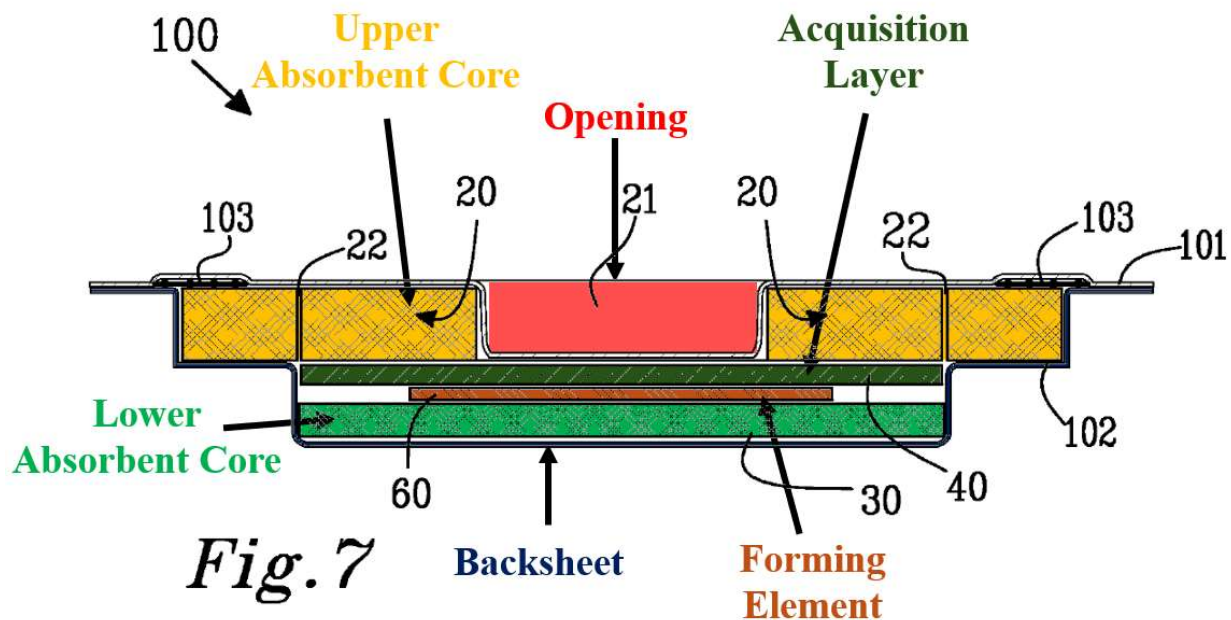
Fig. 4

EX1004-Bergstrom-'059, Figure 4.

64. Bergstrom-'059 describes that the “acquisition layer 40 acts to receive liquid rapidly, to temporarily hold it and to distribute it evenly to the upper and lower absorbent cores 20, 30.” EX1004-Bergstrom-'059, 6:17-19. Bergstrom-'059 explains that the acquisition layer can contain or be made from fibrous materials, such as synthetic fibers. EX1004-Bergstrom-'059, 6:20-21. Bergstrom-'059 also explains that forming element 60 is preferably located between the acquisition layer 40 and the lower absorbent core 30 and helps promote “[l]iquid flow towards the ends of the core.” EX1004-Bergstrom-'059, 9:27-30. Bergstrom-'059 describes

that suitable materials for the forming element 60 are plastic films, perforated plastic films and reinforced tissue or reinforced nonwoven materials. *Id.*, 10:1-4.

65. Figure 7, reproduced below, depicts a cross-sectional view of Bergstrom-'059's absorbent article.



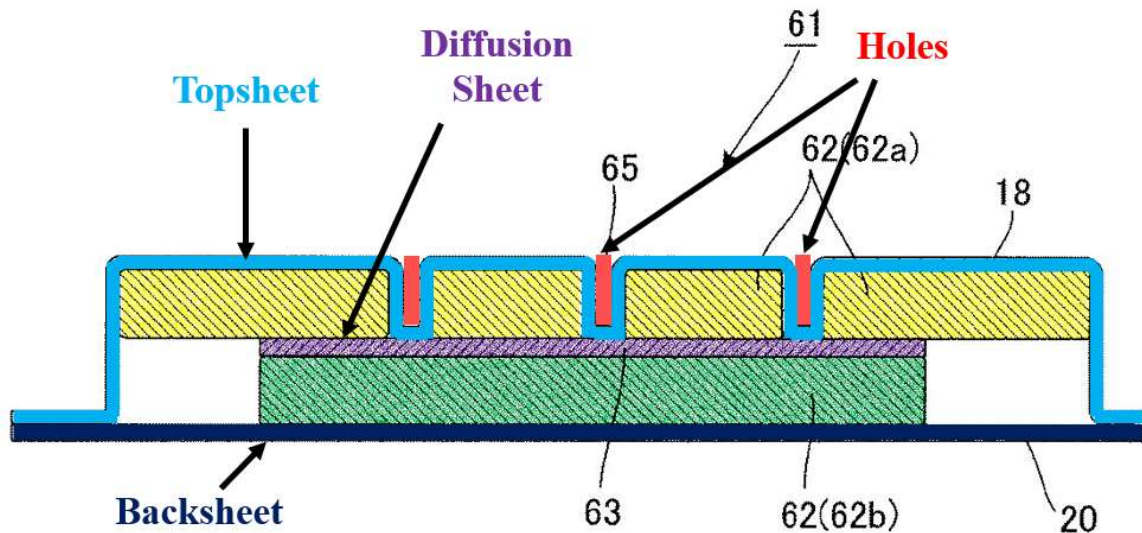
EX1004-Bergstrom-'059, Figure 7.

B. Nakazawa-'190

66. Nakazawa-'190 describes an absorbent article having two layers of absorbent material, a topsheet that is made at least partially of a liquid-permeable material, a backsheet made of a liquid-impermeable material, and a hole portion that penetrates from the top surface to the back surface of the upper layer of absorbent material. EX1008-Nakazawa-'190, [0013]. In one of the examples shown in

Nakazawa, in Figure 14A reproduced below, the topsheet 18 covers the top surface of a first absorbent material 62a. EX1008-Nakazawa-'190, [0084].

[Fig. 14A]



EX1008-Nakazawa-'190, Figure 14A.

67. Nakazawa-'190 states that the first absorbent material 62a comprises hole portions that extend through the first absorbent material. Nakazawa-'190 also describes a diffusion sheet 63 located between the upper absorbent layer and the lower absorbent layer that is exposed to the topsheet in the hole portions 65. EX1008-Nakazawa-'190, [0084]. The topsheet 18 and the diffusion sheet 63 are joined together at the openings in the hole portions 65. EX1008-Nakazawa-'190, [0084]. Nakazawa-'190 explains that in this version of its absorbent article, the

topsheet and the diffusion sheet may be bonded directly or via a hydrophilic sheet in which the upper absorbent material is wrapped. EX1008-Nakazawa-'190, [0084].

68. Nakazawa-'190 describes that the diffusion sheet is located on the back surface of the upper layer of absorbent material and, in the embodiment shown in Figure 14A, covers the lower layer of absorbent material, including the areas where there are openings in the hole portions formed in the upper layer of absorbent material. EX1008-Nakazawa-'190, [0061]. Nakazawa-'190 explains that the diffusion sheet has a higher liquid permeability than the absorbent material, and when excretory fluid flows into the hole portions of the absorbent material, it can permeate the diffusion sheet and diffuse faster than it can be absorbed by the absorbent material. EX1008-Nakazawa-'190, [0061].

69. Nakazawa-'190 explains that its diffusion sheet can be made of a porous plastic film. EX1008-Nakazawa-'190, [0062].

70. Nakazawa-'190 also describes that while not shown in the figures, the absorbent material, (either or both the upper or lower layer), is generally wrapped with a non-porous hydrophilic sheet serving as a carrier to prevent leakage of the superabsorbent polymer. EX1008-Nakazawa-'190, [0082].

C. Glaug-'753

71. Glaug-'753 describes a wearable, disposable absorbent article, e.g., a diaper, arranged to trap and collect fluid waste products. EX1006-Glaug-'753,

EX1006-Glaug-'753, Abstract, 3:54-4:4, 4:9-11; Figure 2.

Glaug-'753, Abstract, 3:54-4:4. Glaug-'753 describes that the fluid acquisition

accommodate. EX1006-Glaug-'753, Abstract (“The fluid acquisition system serves to facilitate the transference of fluid into the core, e.g., spread out the fluid over the core and providing it to the core at a rate at which the materials of the core can accommodate.”); *id.*, 4:5-8 (“The fluid acquisition system cooperates with the core to facilitate the transference of fluid, e.g., urine, into the core for absorption and retention in the core even under repeated insults.”).

73. Glaug-'753 describes a plurality of apertures or pores extending through the top layer 62 of its fluid acquisition system so as to make the material liquid permeable. EX1006-Glaug-'753, 6:39-42. Glaug-'753 states that the fluid acquisition system 34 comprises “an apertured polymeric film 62, which is preferably three dimensional in nature.” EX1006-Glaug-'753, 8:3-7. In a preferred embodiment, Glaug-'753 discloses “the three dimensionally shaped apertures [are] directed inwardly towards the core.” *Id.*, 9:24-27. Glaug-'753 explains that under this configuration, the second surface (i.e., the surface towards which the conically shaped apertures taper) faces the non-perforated polymeric layer 64, which is disposed between the perforated layer 62 and the core 36. *Id.*, 9:27-30.

D. Ponomarenko-'236

74. Ponomorenko-'236 describes an absorbent article including a backsheet, an absorbent core, a topsheet, and a sublayer that includes at least one acquisition layer. EX1007-Ponomarenko-'236, Abstract, claim 1.

Ponomarenko-'236 describes that the sublayer (30) is typically fibrous and “comprises or is typically one or more acquisition layers (e.g., that can temporarily absorb fluids, like urine and pass on or transport the fluid to the absorbent core that is in proximity to said sublayer (30)).” EX1007-Ponomarenko-'236, 6:37-42. Ponomarenko-'236 describes that sublayer 30 “in general . . . serves as . . . an acquisition layer and optionally also (as) a distribution layer, capable to acquire liquid (urine) and temporarily hold the liquid and allow it to pass, or transport it to the absorbent core underneath . . . and optionally also distribute it in the X and Y direction of the sublayer (30).” EX1007-Ponomarenko-'236, 7:8-19.

75. Ponomarenko-'236 explains that it is “[h]ighly preferred ... that the sublayer (30) comprises two or more (acquisition) layers (e.g., a laminate of two or more layers), and that the holes (31) of the sublayer (30) are preferably formed by the (aligned) holes (31) through either the first or second or first and (part of the) second or subsequent layers.” EX1007-Ponomarenko-'236, 6:49-54.

76. Ponomarenko-'236 explains that in some embodiments only some but not all layers of the sublayer have holes. EX1007-Ponomarenko-'236, 9:18-23.

E. Cohen-'429

77. Cohen-429 describes an absorbent article that has a topsheet, an absorbent core and an acquisition/distribution transfer system disposed intermediate the topsheet and absorbent core.” EX1016-Cohen-'429, Abstract. Cohen-'429

further describes that “[t]he system includes at least one aperture material which is three dimensional and defines pores extending appreciably beyond the primary plane of the material in a direction from the absorbent core toward the topsheet. *Id.*, Cohen-’429 describes using a “three dimensional apertured film” sold by Tredegar under the trade name Aquidry as an acquisition/distribution layer. EX1016-Cohen-429, [0032]. Cohen-’429 explains the Tredegar material has an “an average pore size of 0.3-10 mm in diameter, preferably 0.5-5.0 mm, and optimally 1.0-2.0 mm.” EX1016-Cohen-429, [0041] (emphasis added). Cohen-’429 explains that this pore size is “sufficiently large to enable rapid liquid acquisition.” *Id.*, [0024].

IX. CLAIM CONSTRUCTION

78. I was informed and I understand that, in my analysis, I should give claim terms their ordinary and customary meaning, as understood by a person of skill in the art at the time of the invention. I was informed and I understand that the words of the patent’s claims and the context in which the term is used in the claims can be highly instructive in ascertaining the term’s meaning. I further understand that the terms of a claim are to be interpreted in the context of the entire patent, including the patent’s claims, its specification and its figures.

79. I have been further instructed that a patent’s “prosecution history” may often provide helpful evidence about how the Patent Office and the applicant

understood the patent and its claims. Therefore, I have been instructed that claim terms should also be interpreted in light of the patent's prosecution history.

80. In addition to the claims, the specification, the figures and the prosecution history, I have been instructed that certain "extrinsic evidence" such as scientific or technical references may also help inform the way in which the person of ordinary skill in the art might understand the claim term. I have been instructed that extrinsic evidence must always be considered in the context of the intrinsic evidence.

81. In my opinion, the prior art discloses all of the limitations of the challenged claims under any plausible construction and/or under the apparent interpretation of the claims advanced by the Patent Owner in the parallel litigation. I have been informed and understand that in such circumstances, there is no need to construe the terms in the challenged claims.

X. ANALYSIS OF THE GROUNDS

82. It is my opinion that the challenged claims are unpatentable on the following grounds:

- Ground I: Claims 1, 3, 21-22 and 24-25 are anticipated by Bergstrom-'059 under 35 U.S.C. § 102.
- Ground II: Claims 1, 3-5, 20-22 and 24-25 are rendered obvious by Nakazawa-'190 in view of Glaug-'753 under 35 U.S.C. § 103.
- Ground III: Claim 7 is rendered obvious by Nakazawa-'190 in view of Glaug-'753 in view of Cohen under 35 U.S.C. § 103.

- Ground IV: Claims 1-5, 7-8, 21-22 and 24-25 are rendered obvious by Nakazawa-'190 in view of Ponomarenko-'236 under 35 U.S.C. § 103.
- Ground V: Claims 1, 3-5, 21-22 and 24-25 are anticipated by Nakazawa-'190 under 35 U.S.C. § 102.

83. These grounds demonstrate in detail that claims 1-5, 7-8, 20-22, and 24-25 are unpatentable as anticipated and/or obvious. A copy of the Challenged Claims are provided as **Appendix C**.

A. Ground I: Claims 1, 3, 21-22, and 24-25 Are Anticipated By Bergstrom

84. It is my opinion that Bergstrom-'059 anticipates claims 1, 3, 21-22, and 24-25 because it discloses each element of these claims as arranged in the claims.

1. Claim 1

- a. 1[pre]: An absorbent article having a longitudinal direction and a transverse direction, side edges extending in the longitudinal direction and end edges extending in the transverse direction.**

85. I have been informed and understand that, in general, there are circumstances where the preamble of a claim does not limit the scope of the claim, and there are circumstances where the preamble does limit the scope of the claim. I do not have an opinion as to whether the preamble of claim 1 is limiting. It is my opinion that even if the preamble of claim 1 is limiting, Bergstrom-'059 discloses “an absorbent article [e.g., absorbent article 100] having a longitudinal direction and

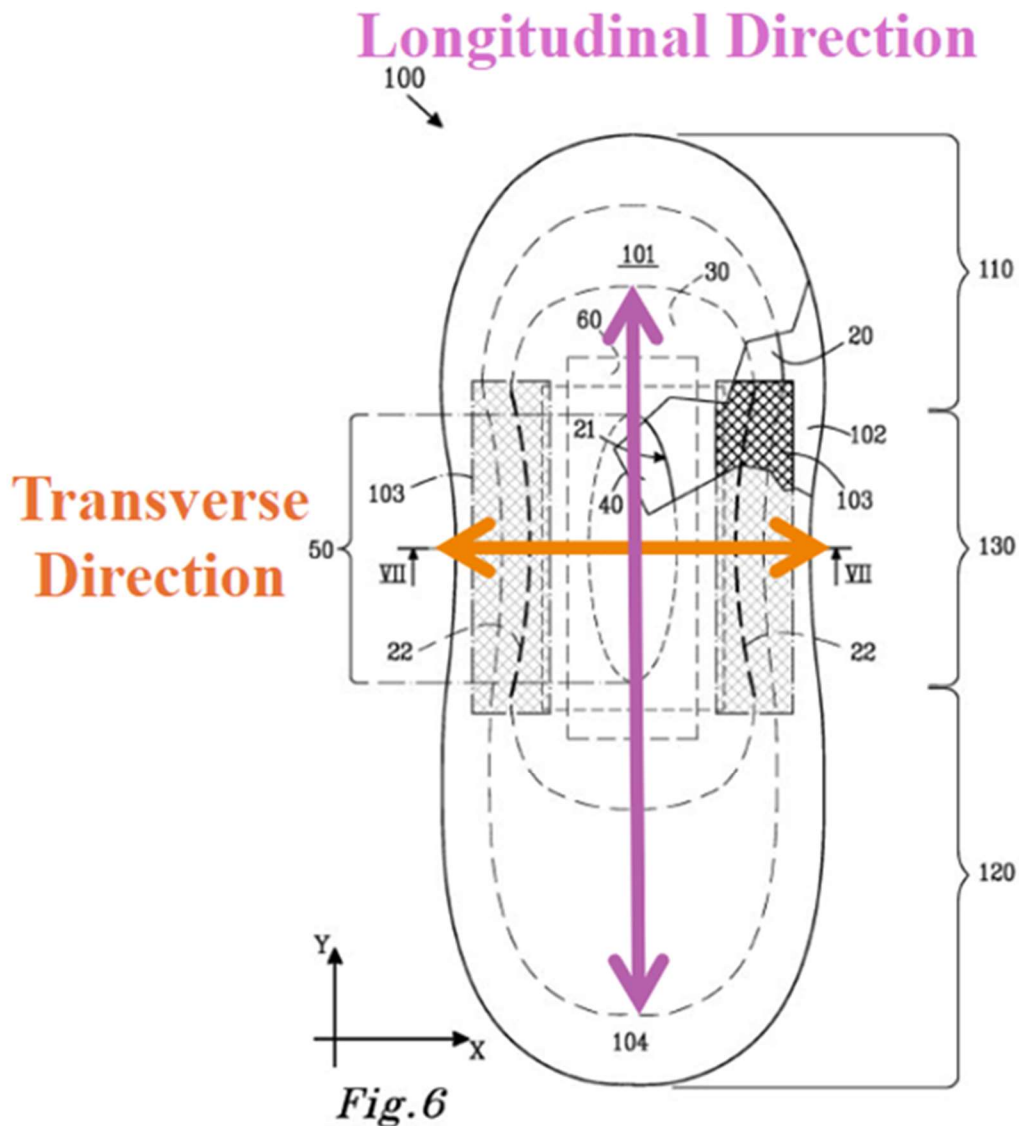
a transverse direction, side edges extending in the longitudinal direction and end edges extending in the transverse direction.”

86. Consistent with what a person of ordinary skill in the art would have understood at the time of the '138 patent's filing, the '138 patent describes the longitudinal direction as the lengthwise direction of the absorbent article, and the transverse direction is the widthwise direction of the absorbent article. EX1001-USP138, 10:61-64 (The incontinence protector 1 in Figures 1 and 2 has two longitudinal side edges 8, 9 having equal length and extending generally in the same direction as a longitudinal center line 10 through the incontinence protector 1. Front and rear end edges 11, 12 extend transversely to the longitudinal center line 10 at the ends of the incontinence protector.”).

87. Bergstrom-'059 discloses “an absorbent article 100.” EX1004-Bergstrom-'059, 10:14-29; *see also, id.*, Abstract (“The invention provides for an absorbent core for an absorbent article”); 1:4-7 (“The present invention relates to an absorbent core for an absorbent article which is capable of adopting a predetermined three-dimensional shape when subject to pressure in the width direction. The invention also relates to an absorbent article comprising said core”), 2:9-13 (“The absorbent core extends in the length (Y), width (X) and thickness (Z) directions.”), 3:11-13, 4:27, Figures 6-8, claim 1.

88. Bergstrom-'059 states that absorbent article 100 “extends in the length (Y), width (X), and thickness (Z) directions.” EX1004-Bergstrom-'059, 10:25-26.

89. As I have annotated below, Bergstrom-'059 shows an absorbent article with side edges that extend along a longitudinal direction and end edges that extend along a transverse direction in Figure 6.



EX1004-Bergstrom-'059, Figure 6.

b. 1[a]: “a fluid permeable top sheet”

90. Bergstrom-’059 describes a fluid permeable topsheet (e.g., topsheet 101).

91. Bergstrom-’059 shows and explains that absorbent article 100 has a “liquid-permeable topsheet 101.” EX1004-Bergstrom-’059, 10:26-27, Figures 6-8; *see also id.*, 3:13-14 (“The absorbent article typically comprises a liquid-permeable topsheet and a liquid-impermeable backsheet.”). Bergstrom-’059 explains the topsheet “lies in contact with the wearer’s body when the article is in use.” *Id.* at 10:31-11:6; *see also* 11:22-34 (describing how the topsheet and backsheet envelop the absorbent core); Abstract, claims 9, 10.

92. I have identified the topsheet in Figure 7, reproduced below:

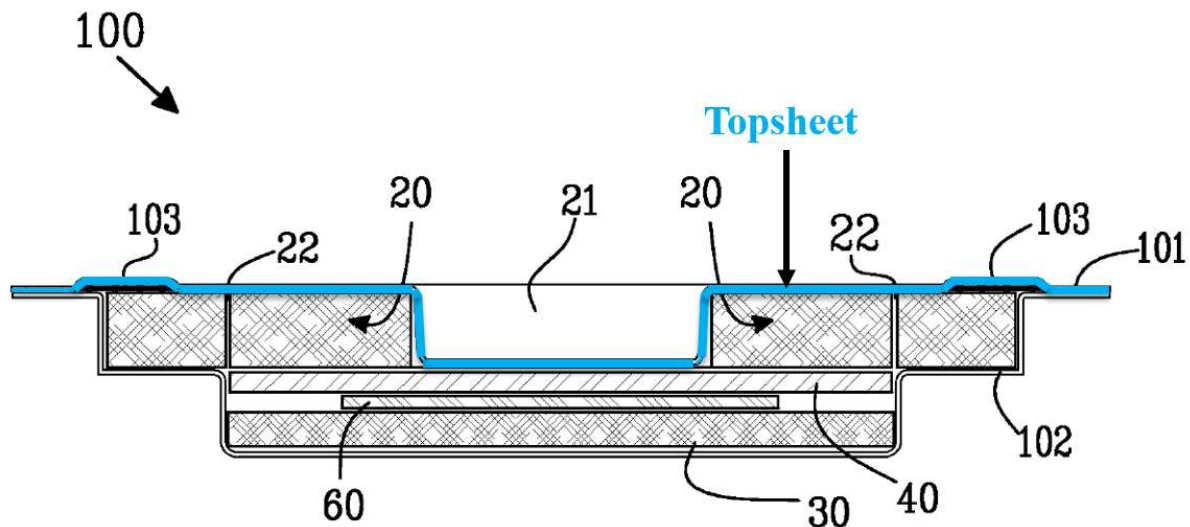


Fig. 7

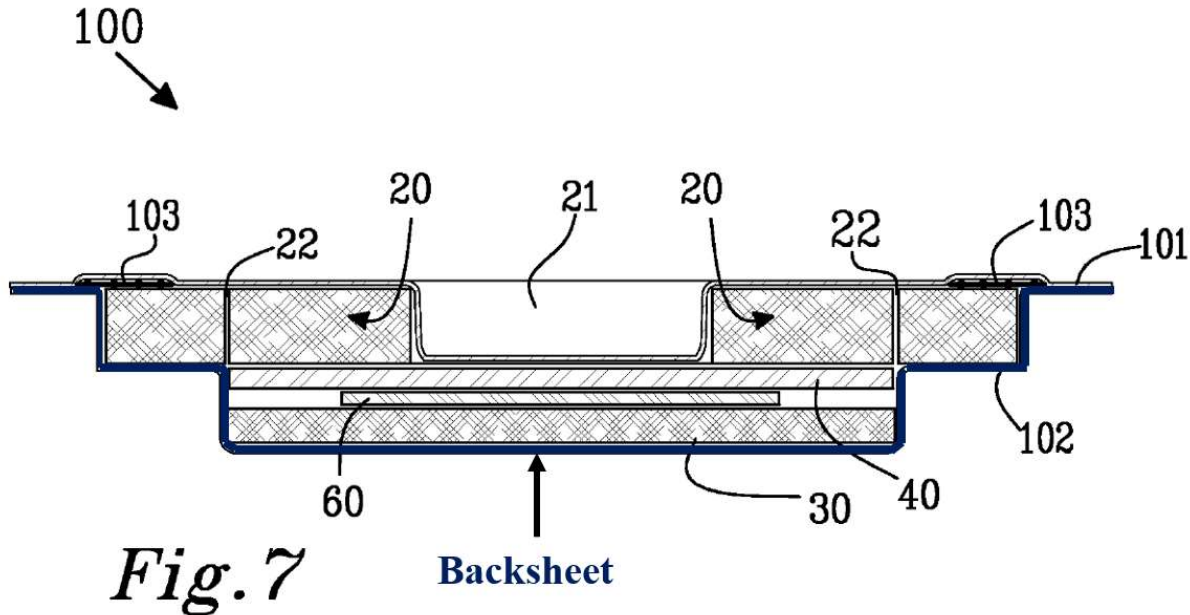
EX1004-Bergstrom-’059, Figure 7.

c. 1[b]: “a fluid impermeable backsheet”

93. Bergstrom-’059 discloses a fluid impermeable backsheet (e.g., backsheet 102).

94. Bergstrom-’059 explains that absorbent article 100 has a “liquid-impermeable backsheet 102.” EX1004-Bergstrom-’059, 10:26-27, Figures 6-8. Bergstrom-’059 explains the backsheet “lies furthest from the wearer’s body when the article is in use. To protect the wearer’s garments from soiling, it should be liquid-impermeable, but is desirably gas-permeable to allow air and vapour to pass in and out of the article. ...” *Id.*, 11:8-20; *see also id.*, 3:13-14 (“The absorbent article typically comprises a liquid-permeable topsheet and a liquid-impermeable backsheet.”); 11:22-34 (describing how the topsheet and backsheet envelop the absorbent core and can be joined to one another); Abstract; claims 9, 10.

95. I have annotated Figure 7 below to show the backsheet:



EX1004-Bergstrom-'059, Figure 7.

d. 1[c]: “an absorbent core enclosed between said topsheet and said backsheet”

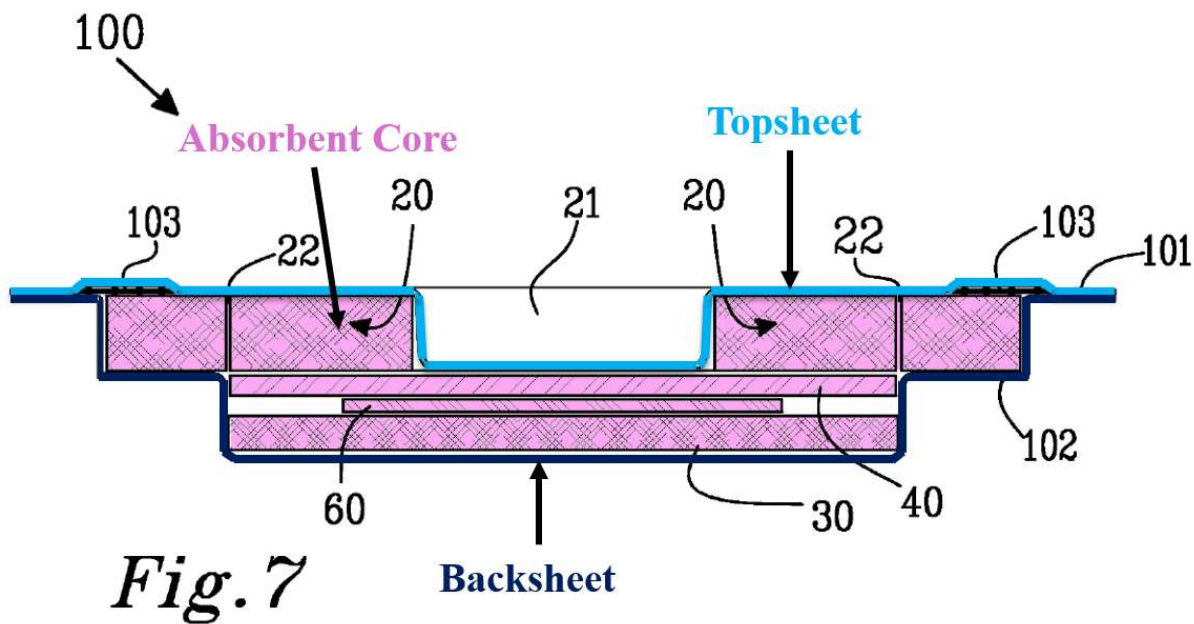
96. Bergstrom-'059 discloses an absorbent core (e.g., absorbent core 10) enclosed between said topsheet (e.g., topsheet 101) and said backsheet (e.g., backsheet 102).

97. Bergstrom-'059 describes, “[t]he topsheet 101 and the backsheet 102 are joined to one another around the periphery of the absorbent core 10, so that the core 10 is enclosed within the envelope formed by the topsheet 101 and the backsheet 102.” EX1004-Bergstrom-'059, 11:23-26, *see also id.*, Figures 6-8. Bergstrom-'059 also describes how “the fluid-permeable topsheet 101 and fluid-impermeable backsheet 102 extend beyond the absorbent core 10 ... and are joined to one another

in the area outside the absorbent core 10.” EX1004-Bergstrom-’059, 11:26-29; *see also id.*, 17:20-24, Figure 7.

98. Bergstrom-’059 explains, “[t]he absorbent core 10 is the component of the absorbent article 100 which receives and contains most liquid and other bodily exudates” and shows that it includes two absorbent layers, an acquisition layer, and a forming layer. EX1004-Bergstrom-’059, 4:27-29; *see also id.*, 2:9-13, 5:8-11, 13-27, 8:14-23, 8:29-32, 10:6-15, 25-29; claims 9, 10.

99. I have annotated Figure 7 below to show the absorbent core enclosed between the topsheet and backsheet.



EX1004-Bergstrom-’059, Figure 7.

- e. **1[d]: “said absorbent core comprising, a first absorbent layer having an opening that passes through the first absorbent layer from one major surface to an opposing major surface and therebetween the opening is surrounded by a closed periphery of first absorbent layer”**

100. Bergstrom-’059 describes a first absorbent layer (e.g., upper core 20) having an opening (e.g., opening 21) that passes through the first absorbent layer from one major surface to an opposing major surface and therebetween the opening is surrounded by a closed periphery of first absorbent layer (e.g., upper absorbent core 20).

101. Bergstrom-’059 states, “the upper core (20) compris[es] an opening (21) located in at least said region (50), such that the opening (21) in the upper absorbent core (20) overlies both the acquisition layer (40) and the lower absorbent core (30).” EX1004-Bergstrom-’059, 16:12-14, Figures 4, 6-8; claim 1. Bergstrom-’059 also explains “[t]he opening in the upper core is suitably located in the centre of the upper core in the width (X) direction.” *Id.* 2:31-32, *see also id.*, 6:33-35 (“The upper absorbent core 20 comprises an opening 21, as shown in Figures 1-8. The opening 21 extends through the entire thickness of the upper absorbent core 20, from one face to the other (*see* Figure 4).”), Abstract, 2:17-20, 2:31-32, 7:2-7, claims 1-2, Figure 4.

102. I have annotated Figures 4 and 7 below to show the opening in the upper absorbent core.

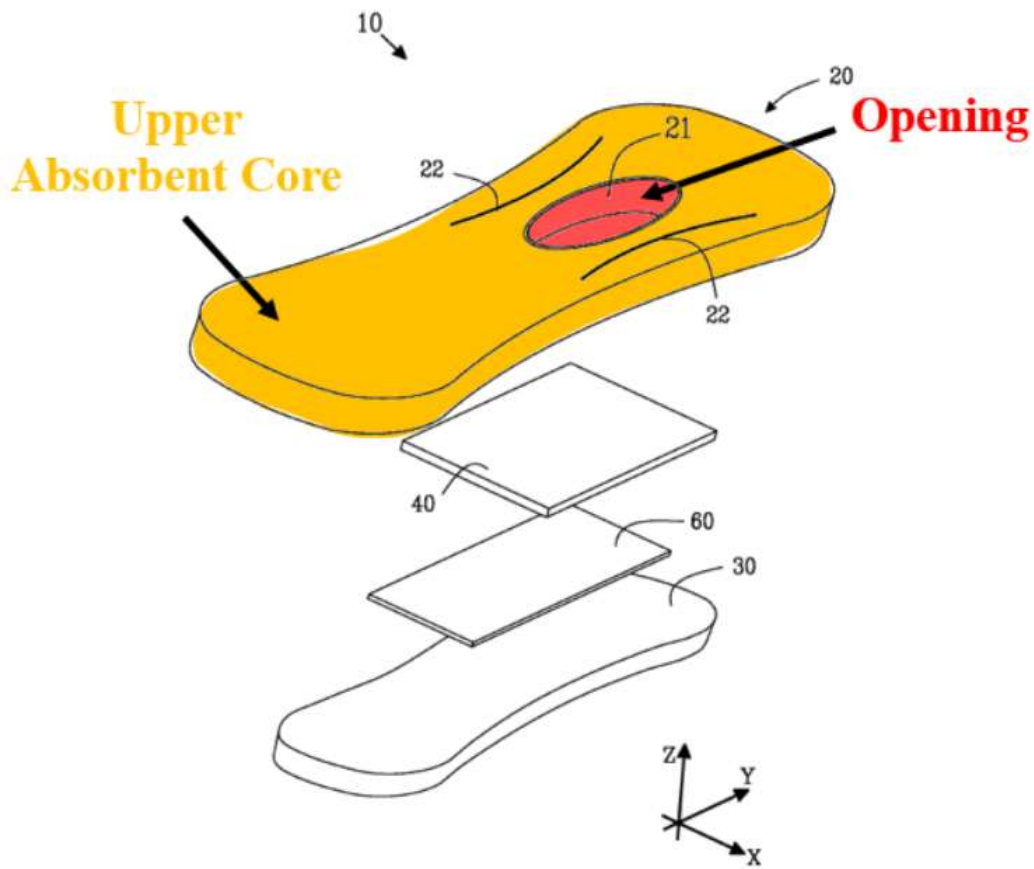


Fig.4

EX1004-Bergstrom-'059, Figure 4.

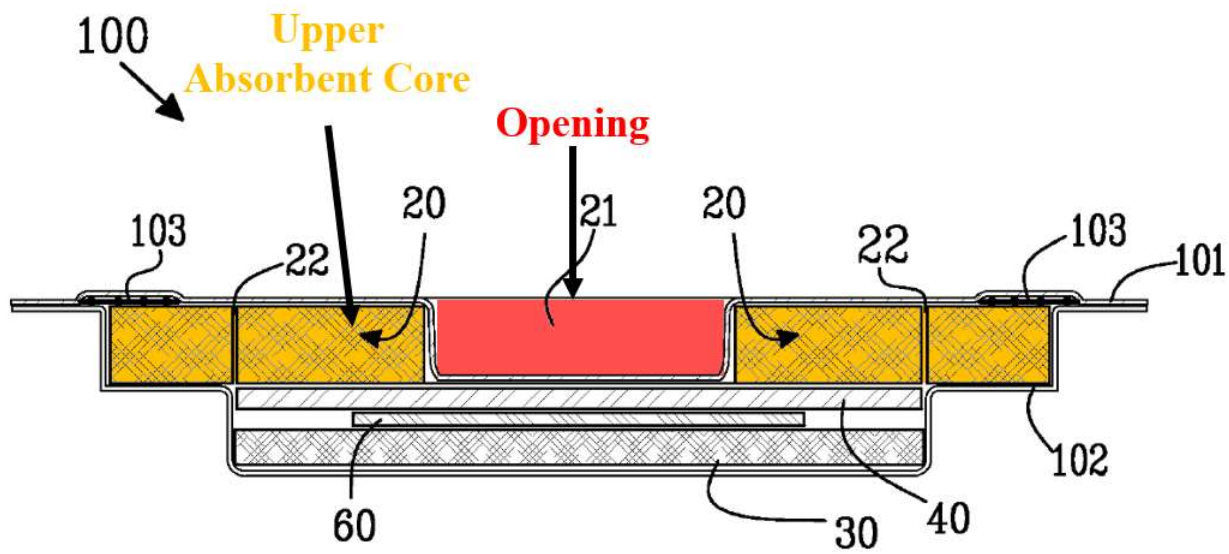


Fig. 7

EX1004-Bergstrom-'059, Figure 7.

f. 1[e]: “said absorbent core comprising . . . a fluid flow control structure”

103. Bergstrom-'059 describes that the absorbent core (e.g., absorbent core 10) comprises a fluid flow control structure (e.g., acquisition layer 40 and forming element 60).

104. The '138 patent states “The fluid flow control structure not only enhances fluid transport away from the initially wetted area but also promotes fluid distribution throughout the absorbent core both in the length direction and in the thickness direction of the article.” EX1001-USP138, 2:31-34.

105. As explained in Bergstrom-'059, both the acquisition layer 40 and forming layer 60 provide the same functionality. For example, Bergstrom-'059 explains that “acquisition layer 40 [that] acts to receive liquid rapidly, to temporarily hold it and to distribute it evenly to the upper and lower absorbent cores 20, 30.” EX1004-Bergstrom-'059, 6:17-20. Bergstrom-'059 explains that the acquisition layer typically comprises “fibrous materials, such as e.g., synthetic fibers.” EX1004-Bergstrom-'059, 6:20-21. Bergstrom-'059 further explains that the acquisition layer has an extension in the X-direction which is less than that of the upper core in at least said region. EX1004-Bergstrom-'059, 2:15-20. Bergstrom-'059 explains that this thus allows liquid to reach the outer edges of the absorbent core more effectively. *Id.*, 9:27-30.

106. Bergstrom-'059 also explains that “the invention may additionally comprise a resilient forming element 60 ... preferably located between the acquisition layer 40 and the lower absorbent core 30” that “is typically liquid-impermeable,” and “makes best use of the upper and lower absorbent cores 20, 30 by distributing liquid at least in the width (X) direction.” EX1004-Bergstrom-'059, 8:30-9:27. In addition, Bergstrom-'059 explains that liquid flow towards the ends of the core 10 is promoted” by the fact that “the forming element 60 may have an extension in the length (Y) direction which is less than the extensions of the upper and lower absorbent cores 20,30 in this direction.” *Id.*, 9:27-30. *see also id.*, 2:34-3:4, 6:23-31, 8:14-23, 9:34-35, 10:6-12, claims 1, 5, 6; *id.*, Figures 4 and 6-8.

107. I have annotated Figures 4 and 7 below to show the fluid flow control structure that is described in Bergstrom-'059.

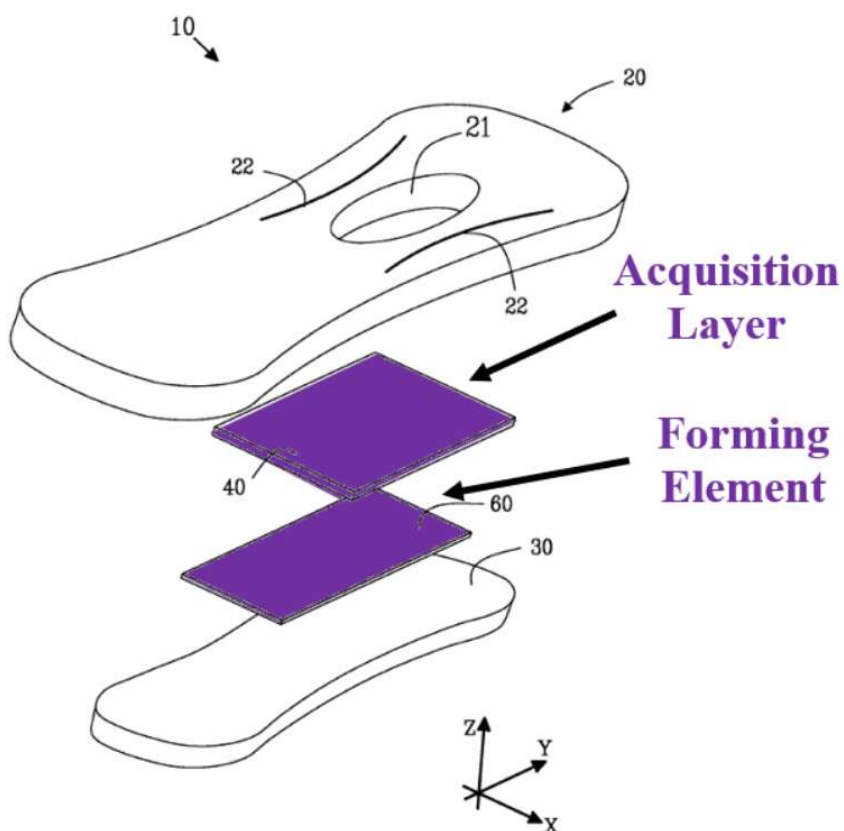


Fig. 4

EX1004-Bergstrom-'059, Figure 4.

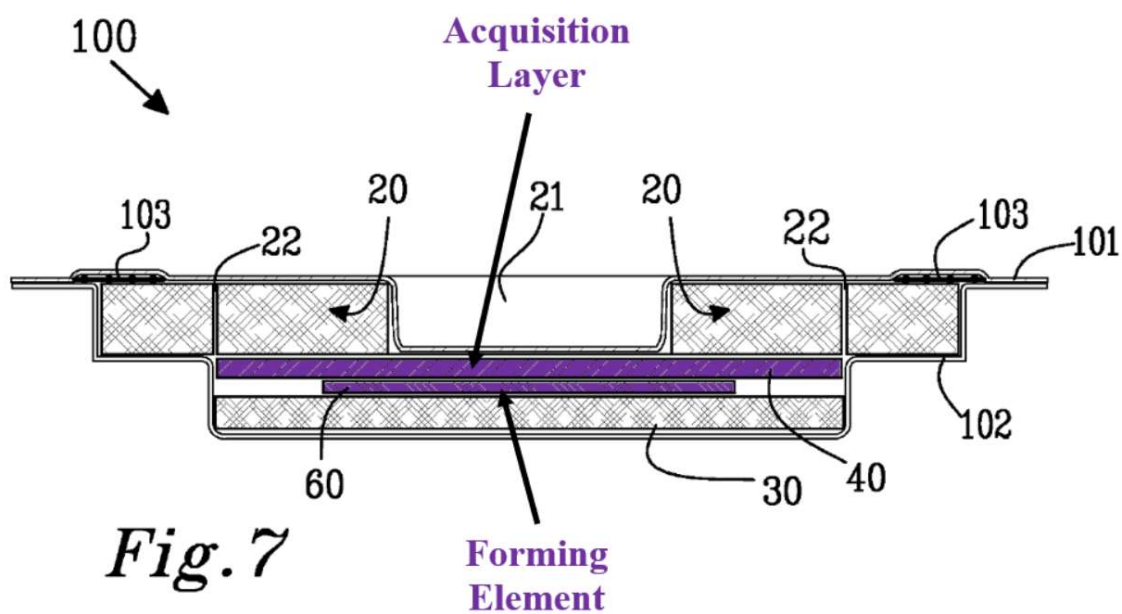


Fig. 7

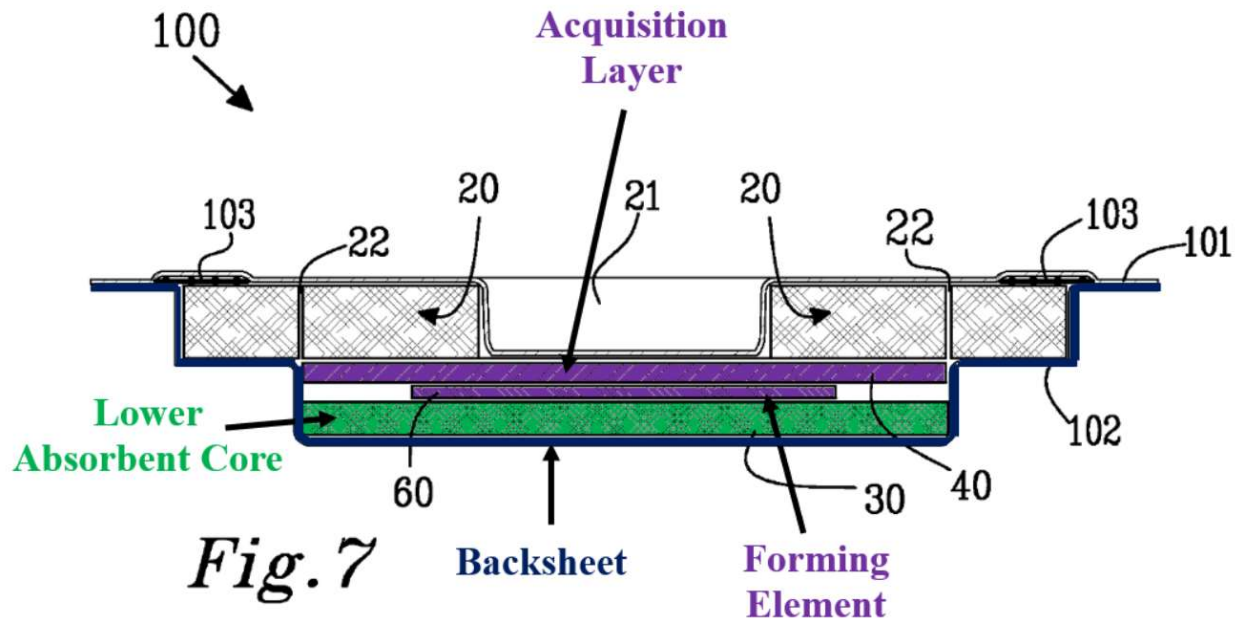
EX1004-Bergstrom-'059, Figure 7.

- g. 1[f]: “said absorbent core comprising . . . a second absorbent layer arranged between the fluid flow control structure and the fluid impermeable backsheet”**

108. Bergstrom-’059 describes an absorbent core (e.g., absorbent core 10) comprising a second absorbent layer (e.g., lower absorbent core 30) arranged between the fluid flow control structure (e.g., acquisition layer 40 and forming element 60) and the fluid impermeable backsheet (e.g., backsheet 102).

109. Bergstrom-’059 describes that “[t]he forming element 60 is preferably located between the acquisition layer 40 and the lower absorbent core 30 . . . ,” EX1004-Bergstrom-’059, 8:32-33. Bergstrom-’059 also depicts the lower absorbent core between the backsheet, and the acquisition layer and forming element in Figure 7; *see also id.*, Abstract, 2:10-13 (“the absorbent core comprises an upper absorbent core and a lower absorbent core”), 5:13-27 (“The absorbent core 10 has a layer structure comprising two cores – an upper absorbent core 20 located on the wearer-facing side of the absorbent core 10 and a lower absorbent core 30 located on the garment-facing side of the core 10.”), 5:29-6:5 (“[a]n acquisition layer 40 is located between said upper 20 and said lower 30 absorbent cores in the thickness (Z) direction. The acquisition layer 40 acts to receive liquid rapidly, to temporarily hold it and to distribute it evenly to the upper and lower absorbent cores”), 6:17-21, 7:2-7, 7:30-32, 8:14-18, 8:32-33, 9:21-29, 10:6-12, Figures 6-8, claims 1, 5.

110. I have annotated Figure 7 below to show the lower absorbent core arranged between the fluid flow control structure and the fluid impermeable backsheet.



EX1004-Bergstrom-'059, Figure 7.

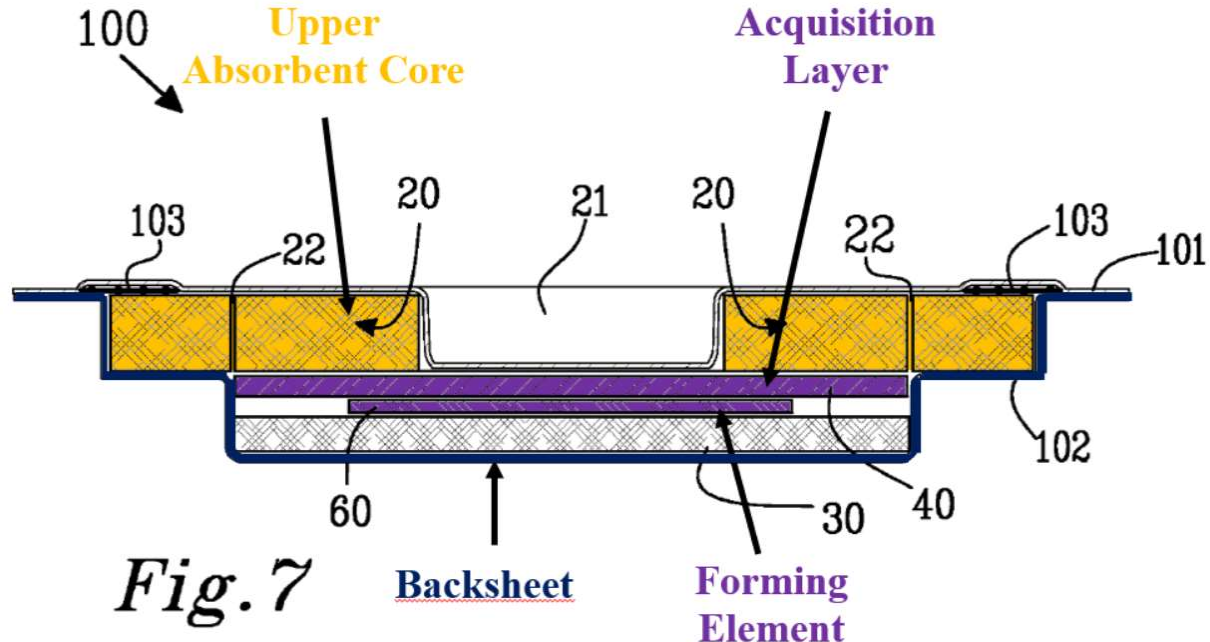
- h. 1[g]: “wherein the fluid flow control structure is arranged between said first absorbent layer and said backsheet”**

111. Bergstrom-'059 explains that the fluid flow control structure (e.g., acquisition layer 40 and forming element 60) is arranged between said first absorbent layer (e.g., upper absorbent core 20) and said backsheet (e.g., backsheet 102).

112. Bergstrom-'059 describes “an acquisition layer (40) being located between said upper (20) and said lower (30) absorbent cores.” EX1004-Bergstrom-'059, 16:8-9. Bergstrom-'059 discloses, “[T]he absorbent core 10

according to the invention may additionally comprise a resilient forming element 60 which underlies at least the opening 21 in the upper absorbent core 20.” *Id.*, 8:20-32. Bergstrom-’059 also states, “The forming element 60 is preferably located between the acquisition layer 40 and the lower absorbent core 30....” *Id.*, 8:32-33. Bergstrom-’059 depicts the acquisition layer and forming element (i.e., the fluid flow control structure) arranged between the upper core (i.e., first absorbent core) and the backsheet in Figures 4 and 7; *see also id.*, 2:34-3:4, 8:29-9:5, 10:6-12, Figures 6-8, claims 1, 4, 5, 10.

113. I have annotated Figures 7 and 4 below to show the upper absorbent core, the fluid flow control structure, and the backsheet.



EX1004-Bergstrom-’059, Figure 7.

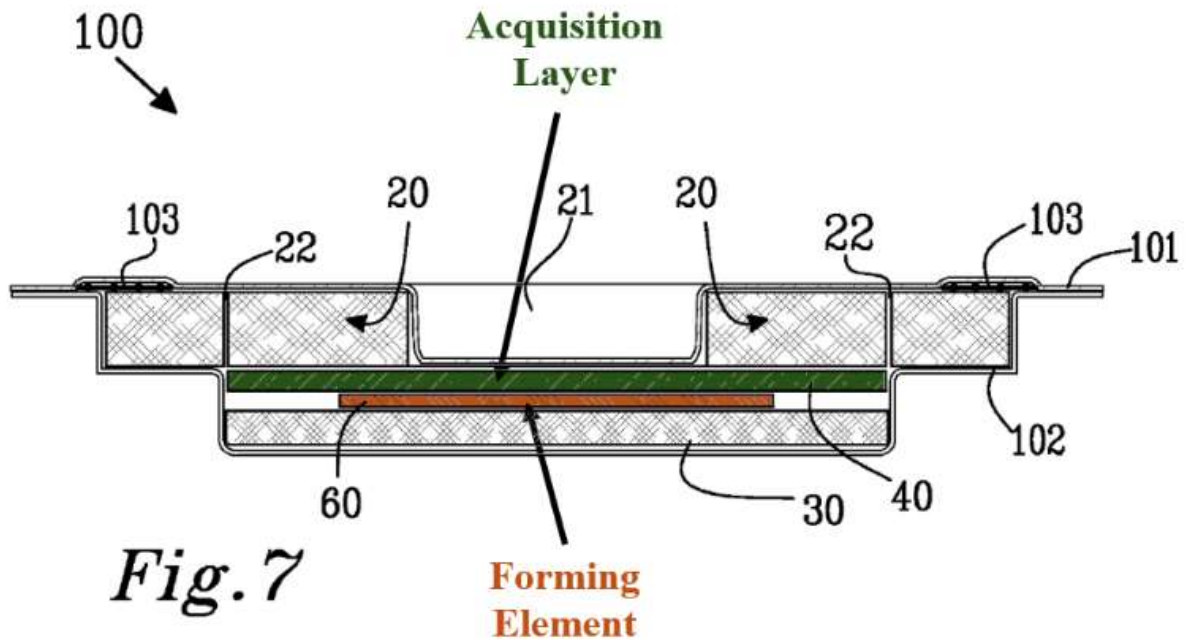
- i. **1[h]: “said fluid control structure being a layered structure comprising a non-perforated fibrous polymeric layer and a first perforated polymeric layer”**

114. Bergstrom-’059 discloses a fluid control structure being a layered structure comprising a non-perforated fibrous polymeric layer (e.g., acquisition layer 40) and a first perforated polymeric layer (e.g., forming element 60).

115. Bergstrom-’059 describes acquisition layer 40 “suitably comprises fibrous materials, such as e.g., synthetic fibres.” EX1004-Bergstrom-’059, 6:20-21. In Bergstrom-’059 the acquisition layer 40 is included “to receive liquid rapidly, and to temporarily hold it and distribute it evenly to the upper and lower absorbent cores 20, 30.” EX1004-Bergstrom-’059, 6:24-31, 10:6-11, Figures 4, 6-8. The acquisition layer in Bergstrom-’059 is necessarily not perforated because (1) Bergstrom-’059 does not disclose it has any perforations, but elsewhere explicitly identifies which layers can be perforated (e.g., 11:4-6 (apertured topsheet); 10:1-3 (perforated plastic film); and (2) a person of ordinary skill in the art would know that a layer of synthetic fibers as it is described would not need to be perforated.

116. Bergstrom-’059 also explains how the forming layer 60 is a perforated polymeric layer. It discloses “suitable materials for the forming element 60 are plastic films, perforated plastic films and reinforced tissue or reinforced nonwoven materials.” EX1004-Bergstrom-’059, 10:1-4.

117. I have annotated Figures 7 and 4 below to show the non-perforated acquisition layer and the perforated forming element.



EX1004-Bergstrom-'059, Figure 7.

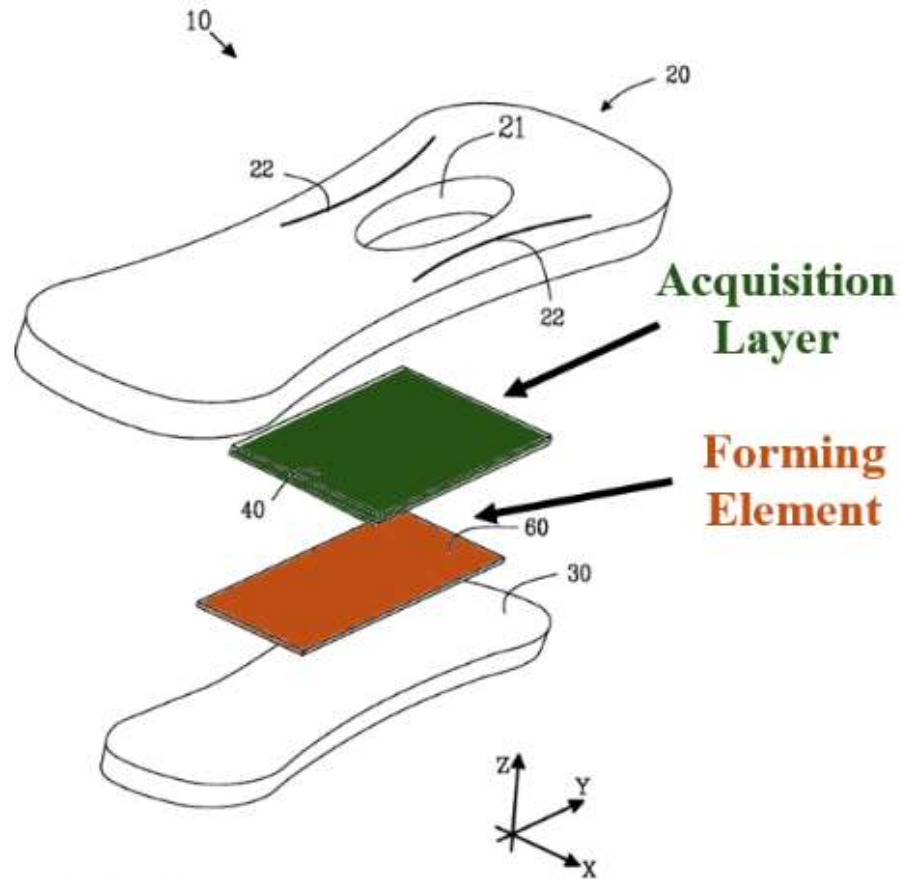


Fig. 4

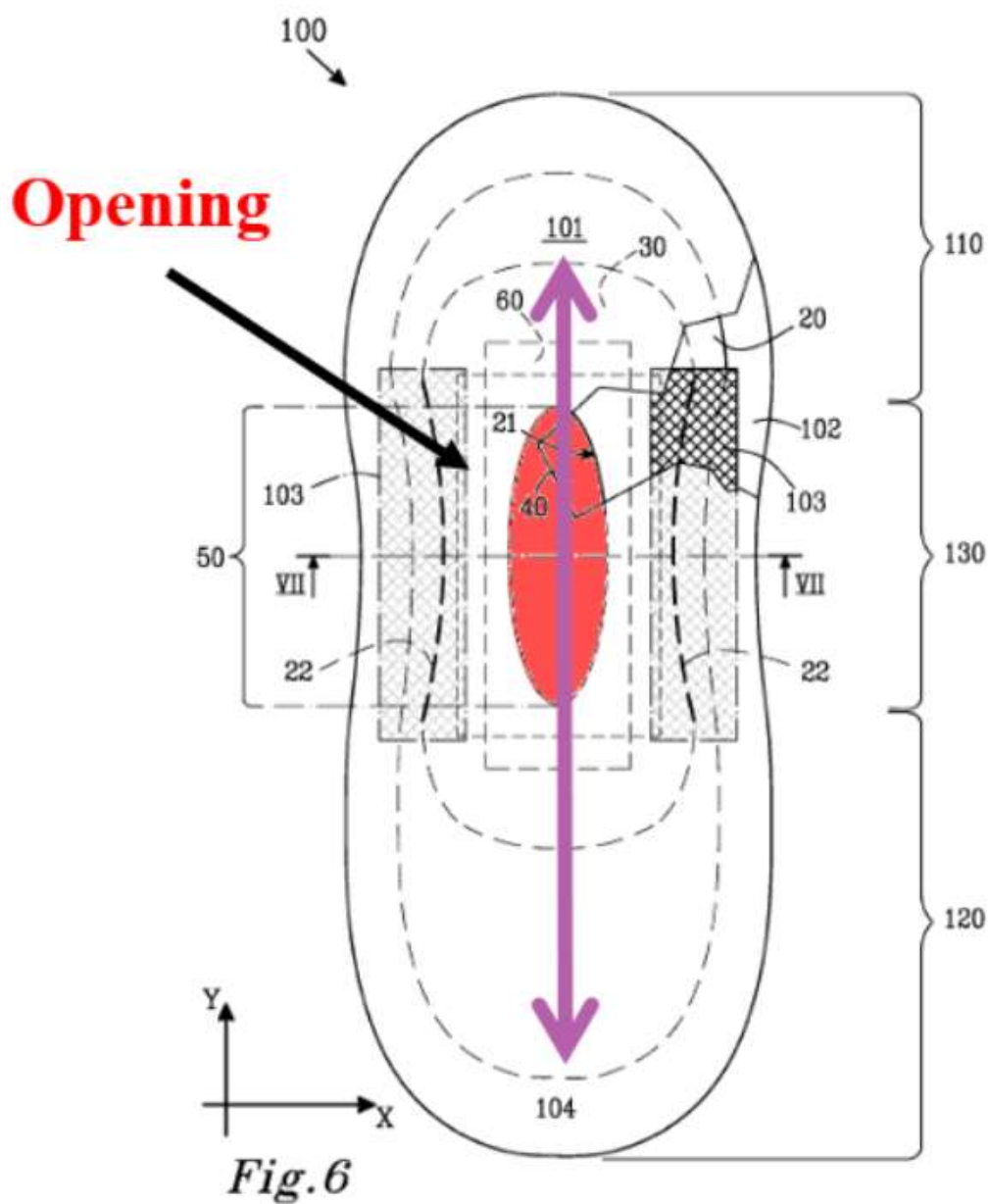
EX1004-Bergstrom-'059, Figure 4.

- j. 1[i]: “wherein the opening extends along a longitudinal center line of the absorbent article, the longitudinal center line being in parallel with the longitudinal direction of the absorbent article”

118. Bergstrom-'059 explains that the opening (e.g., opening 21) extends along a longitudinal center line of the absorbent article, the longitudinal center line being parallel with the longitudinal direction of the absorbent article (e.g., absorbent article 100).

119. Bergstrom-'059 shows and describes the opening 21 extending along the "X-Y" plane of the absorbent article. *See, e.g.*, EX1004-Bergstrom-'059, 7:4-7 ("The opening 21 should have a surface area in the X-Y plane...."). Further, Bergstrom-'059 explains "[t]he opening in the upper core is suitably located in the centre of the upper core in the width (X) direction." *Id.*, 2:31-32; *see also id.*, 8:14-21, 8:25-28, Figures 4, 6-8, claim 2.

120. I have annotated Figure 6 below to show how the opening 21 extends along a longitudinal center line of the absorbent article (the purple line), the longitudinal center line being in parallel with the longitudinal direction of the absorbent article:



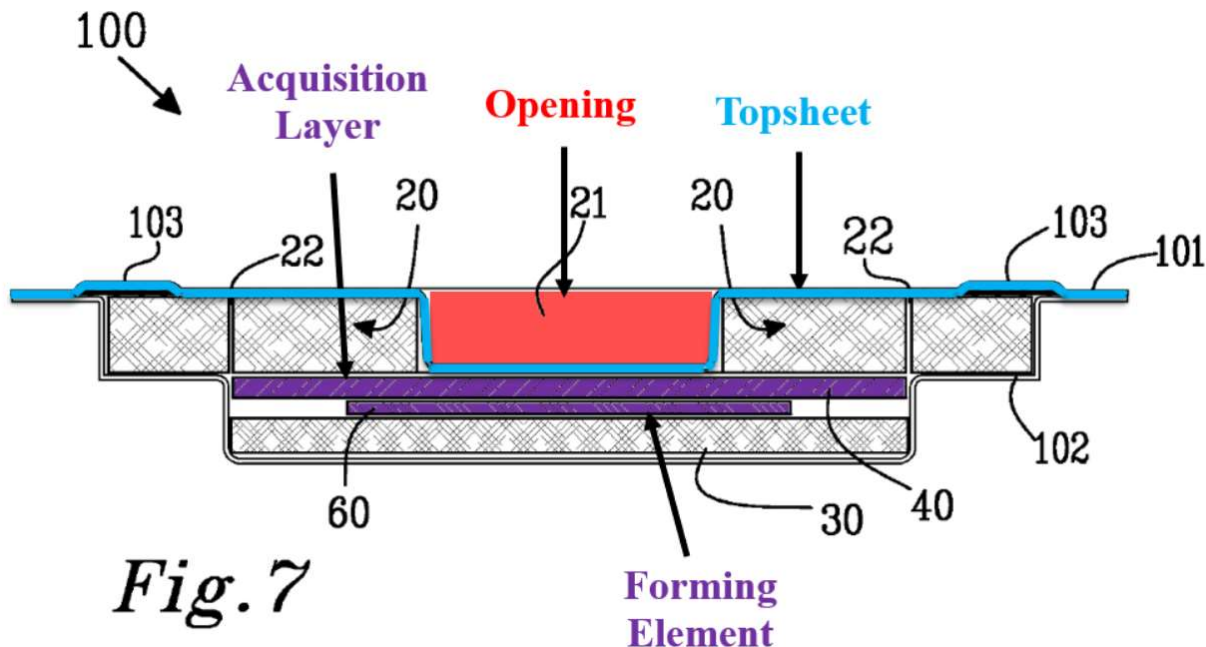
EX1004-Bergstrom-'059, Figure 6.

- k. 1[j]: “the fluid permeable topsheet is in direct contact with the fluid flow control structure via the opening.”

121. Bergstrom-’059 describes a fluid permeable topsheet (e.g., topsheet 101) in direct contact with the fluid flow control structure (e.g., acquisition layer 40 and forming element 60) via the opening (e.g., opening 21).

122. Bergstrom-’059 explains “the topsheet 101 is joined to the upper absorbent core 20 even within the opening 21, so that it makes contact with the acquisition layer 40 (as shown in Figure 7).” EX1004-Bergstrom-’059, 11:31-34, Figure 7.

123. I have annotated Figure 7 below to show the direct contact between the topsheet and the acquisition layer of the fluid flow control structure.



EX1004-Bergstrom-’059, Figure 7.

124. Accordingly, because Bergstrom-'059 discloses each of the elements or limitations of claim 1 and arranged in the same way as in claim 1, it is my opinion that Bergstrom-'059 anticipates claim 1 and therefore renders it invalid.

**2. Claim 3: “The absorbent article according to claim 1,
wherein the first perforated polymeric layer is a nonwoven,
a film or a film/nonwoven laminate”**

125. For the reasons explained above, it is my opinion that Bergstrom-'059 discloses all the elements of claim 1. It is also my opinion that Bergstrom-'059 discloses the additional limitation required by claim 3.

126. For example, Bergstrom-'059 describes a first perforated polymeric layer that is a nonwoven, film or a film/nonwoven laminate (e.g., forming element 60).

127. Bergstrom-'059 states, “suitable materials for the forming element 60 are plastic films, *perforated plastic films* and reinforced tissue or reinforced *nonwoven materials*.” EX1004-Bergstrom-'059, 10:1-4 (emphasis added). Bergstrom-'059 further explains, “Combinations of such materials in laminate form are also possible.” *Id.*

128. Because Bergstrom-'059 discloses each of the elements of claim 1 and dependent claim 3 as arranged in the claims, it is my opinion that Bergstrom-'059 anticipates claim 3 and renders it invalid.

3. Claim 21: “The absorbent article according to claim 1, wherein the opening extends through the entire crotch portion of the absorbent article.”

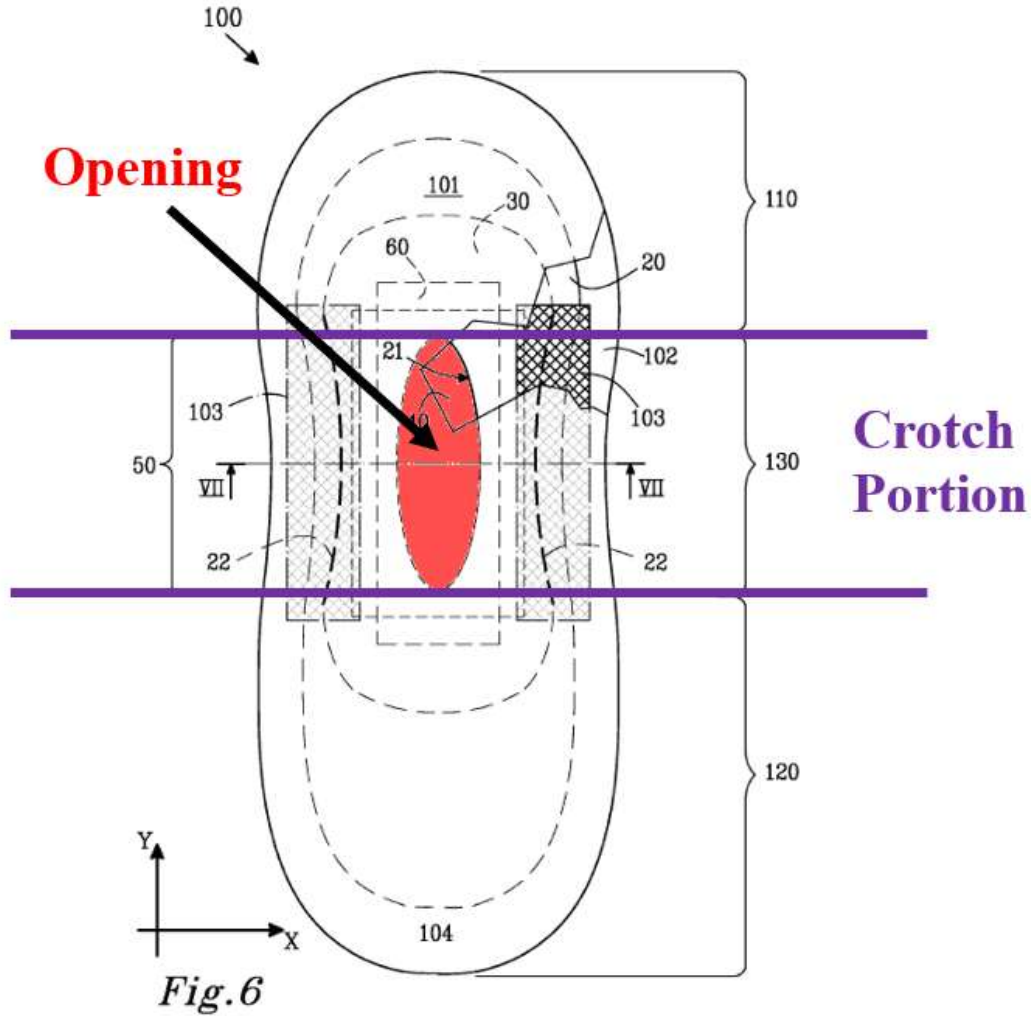
129. For the reasons explained above, it is my opinion that Bergstrom-’059 discloses all the elements of claim 1. It is also my opinion that Bergstrom-’059 discloses the additional limitation required by claim 21.

130. Bergstrom-’059 describes an opening (e.g., opening 21) that extends through the entire crotch portion of the absorbent article (e.g., absorbent article 100).

131. Bergstrom-’059 states its absorbent article has “a crotch portion 130 located between said front and rear portions 110, 120 in the length direction (Y) of the article 100,” and further explains the opening 21 is “located in at least region 50.” EX1004-Bergstrom-’059, 7:2-4. As shown in Figure 6, crotch portion 130 and region 50 are coextensive with one another.

132. Moreover, claim 1 of Bergstrom-’059 describes that the opening is “located in at least said region (50), such that the opening (21) in the upper absorbent core (20) overlies both the acquisition layer (40) and the lower absorbent core (30).” *Id.*, 16:1-14.

133. I have annotated Figure 6 below to show how the opening 21 extends through the entire crotch portion 103 and region 50 of the absorbent article:



EX1004-Bergstrom-'059, Figure 6.

134. Because Bergstrom-'059 discloses each of the elements of claim 1 and dependent claim 21 as arranged in the claims, it is my opinion that Bergstrom-'059 anticipates claim 21 and renders it invalid.

**4. Claim 22: “The absorbent article according to claim 1,
wherein the fluid permeable top sheet is not perforated.”**

135. For the reasons explained above, it is my opinion that Bergstrom-’059 discloses all the elements of claim 1. It is also my opinion that Bergstrom-’059 discloses the additional limitation required by claim 22.

136. Bergstrom-’059 describes a fluid permeable topsheet (e.g., topsheet 101) that is not perforated.

137. Bergstrom-’059 states that the topsheet 101 can consist of “a nonwoven material, e.g., spunbound, meltblown, carded, hydroentangles, wetlaid etc.,” and further instructs that “[s]uitable nonwoven materials can be composed of natural fibers, such as woodpulp or cotton fibres, manmade fibres, such as polyester, polyethylene, polypropylene, viscose etc.” EX1004-Bergstrom-’059, 10:33-11:5. A person of ordinary skill in the art would know that these materials form a topsheet that is not perforated. Nonwovens are porous in nature and move (wick) fluids rapidly if made from the right type of material, like the materials listed in Bergstrom-059. *See, e.g.,* EX1019-EP0701805, [0001] (“Nonwoven fabrics are inherently porous structures [and] [o]wing to their desirable characteristics, nonwovens have been employed as facing materials [e.g., topsheets] for absorbent products such as disposable diapers, sanitary napkins, incontinence devices, wound dressings and the like.”). Perforations would not be needed in order for the nonwovens listed in Bergstrom-’059 to be used in forming the topsheet. In contrast, where plastic films

are used, the film must be perforated (i.e., apertured) in order to meet the functional requirements of a topsheet. *See, e.g.*, EX1019-EP0701805, [0002] (“More recently, efforts have been made to produce porous or liquid-permeable facing materials for absorbent products by using plastic films as the starting materials” for example by “produc[ing] an apertured plastic film”); [0064] (describing the use of “apertured films . . . as facing materials for absorbent products such as disposable diapers, sanitary napkins, wound dressings, incontinent devices and the like”).

138. Bergstrom-’059 also lists alternative materials for forming the topsheet, such as an “apertured plastic film.” But because Bergstrom-’059 suggests that the topsheet may comprise porous, non-perforated non-woven materials *or* an “apertured plastic film” it is clear from Bergstrom that perforations are not required and there are necessarily non-perforated materials that can be used for the topsheet. EX1004-Bergstrom-’059, 11:4-5.

139. Because Bergstrom-’059 discloses each of the elements of claim 1 and dependent claim 22 as arranged in the claims, it is my opinion that Bergstrom-’059 anticipates claim 22 and renders it invalid.

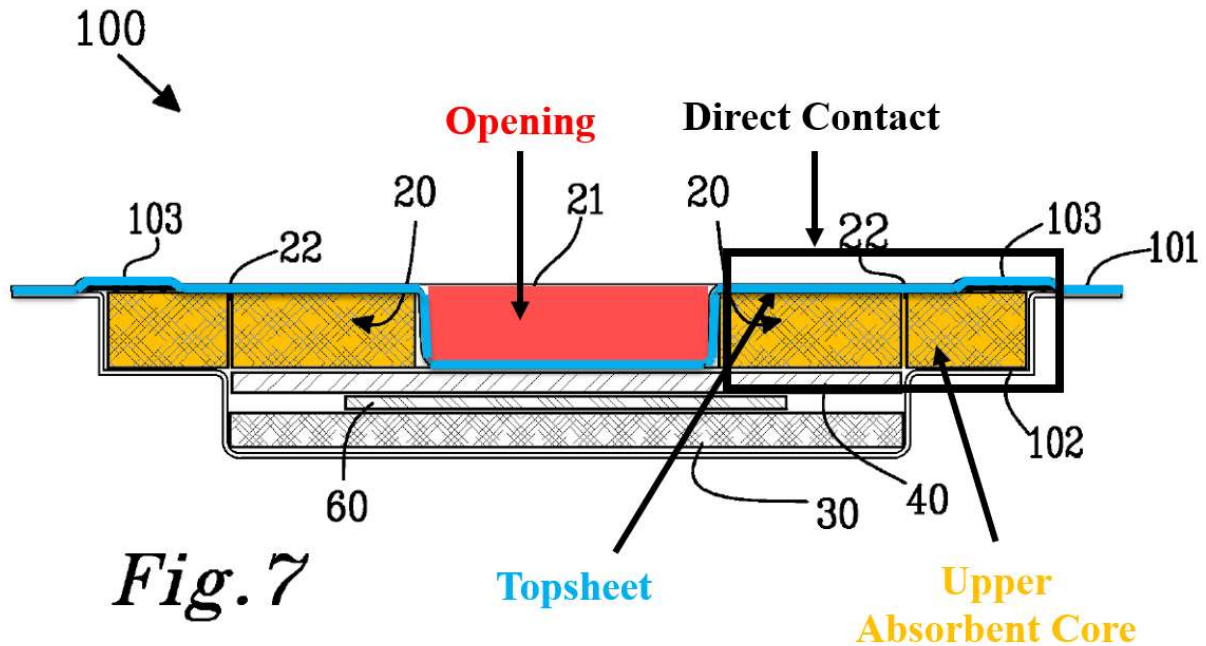
5. Claim 24: “The absorbent article according to claim 1, wherein the fluid permeable top sheet is in contact with the first absorbent layer of the absorbent core at an area other than where the opening is located.”

140. For the reasons explained above, it is my opinion that Bergstrom-’059 discloses all the elements of claim 1. It is also my opinion that Bergstrom-’059 discloses the additional limitation required by claim 24.

141. Bergstrom-’059 describes a fluid permeable topsheet (e.g., topsheet 101) in contact with the first absorbent layer (e.g., upper absorbent core 20) of the absorbent core (e.g., absorbent core 10) at an area other than where the opening (e.g., opening 21) is located.

142. Bergstrom-’059 states, “[t]he topsheet 101 and backsheets 102 may be joined to one another, and to the core 10, by any means common in the art, e.g., ultrasonic welding, thermal welding or gluing.” EX1004-Bergstrom-’059, 11:29-31; *see also id.*, 3:14-16 (“The liquid-permeable topsheet and liquid-impermeable backsheet may extend beyond the absorbent core in at least the width (X) direction and be joined to one another in the area outside the absorbent core to form an edge-seam.”), claim 10.

143. As shown in Figure 7, annotated below, Bergstrom-’059 depicts the fluid permeable topsheet in contact with the upper core (i.e., the first absorbent layer) at an area other than where the opening is located.



EX1004-Bergstrom-'059, Figure 7.

144. Because Bergstrom-'059 discloses each of the elements or limitations of claim 1 and 24 and arranged in the same way as in claim 1 and 24, it is my opinion that Bergstrom-'059 anticipates claim 24 and therefore renders it invalid.

6. **Claim 25: “The absorbent article according to claim 1, wherein the fluid permeable topsheet is in contact with the fluid flow control structure via the opening, such that a cavity is formed along the longitudinal center line of the absorbent article.”**

145. For the reasons explained above, it is my opinion that Bergstrom-'059 discloses all the elements of claim 1. It is my opinion that Bergstrom-'059 discloses the additional limitation required by claim 25.

146. Bergstrom-'059 describes a fluid permeable topsheet (e.g., topsheet 101) that is in contact with the fluid flow control structure (e.g., acquisition layer 40

147. As shown in Figure 7, annotated below, there is no material between the acquisition layer 40 (i.e., the fluid flow control structure) and the topsheet 101 at the opening 21, which forms a cavity. EX1004-Bergstrom-'059, 11:31-34 (“Typically, the topsheet 101 is joined to the upper absorbent core 20 even within the opening 21, so that it makes contact with the acquisition layer 40 (as shown in Figure 7).”).



- 74 -

B. Ground II: Claims 1, 3-5, 20-22 and 24-25 Are Obvious Over Nakazawa-'190 in view of Glaug-'753

149. As I explain in detail below, it is my opinion that Nakazawa-'190 in view of Glaug-'753 renders claims 1, 3-5, 20-22, and 24-25 obvious.

1. Claim 1

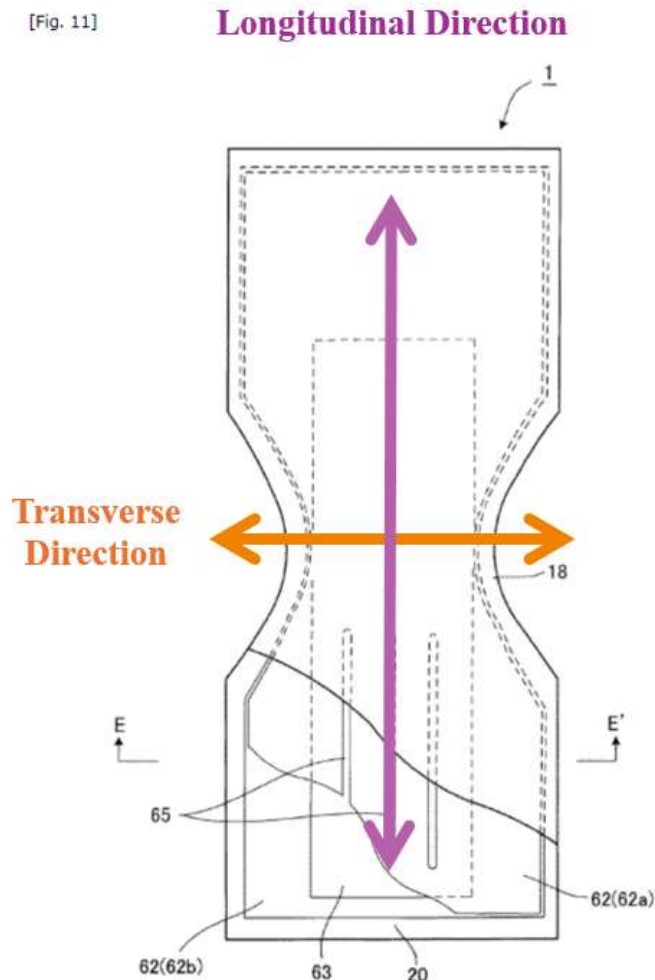
- a. 1[pre]: An absorbent article having a longitudinal direction and a transverse direction, side edges extending in the longitudinal direction and end edges extending in the transverse direction.**

150. As I explained above, I have been informed and understand that, in general, there are circumstances where the preamble of a claim does not limit the scope of the claim, and there are circumstances where the preamble does limit the scope of the claim. I do not have an opinion as to whether the preamble of claim 1 is limiting. Even if the preamble is limiting, Nakazawa-'190 discloses an absorbent article (e.g., absorbent article 1) having a longitudinal direction and a transverse direction, side edges extending in the longitudinal direction and edges extending in the transverse direction.

151. Nakazawa-'190 depicts many absorbent articles that have different configurations. EX1008-Nakazawa-'190, Figures 1-27. In my opinion, I have generally focused on the absorbent article that is shown in Figures 11 and 14A, though descriptions and explanations of other figures may also be relevant to my analysis, where noted below. Further, Nakazawa-'190's descriptions of the different

layers apply to multiple configurations. For example, Nakazawa-'190's description of the diffusion sheet at paragraphs 61 – 71 applies to the diffusion sheets depicted in the different figures.

152. As shown in Figure 11, Nakazawa-'190 discloses “an absorbent article 1.” EX1008-Nakazawa-'190, [0074]; *see also id.*, Abstract, claim 1. I have annotated Figure 11 below to show how Nakazawa-'190's absorbent article has side edges that extend along a longitudinal direction (along the length of the article) and end edges that extend along a transverse direction (along the width of the article).



EX1008-Nakazawa-'190, Figure 11.

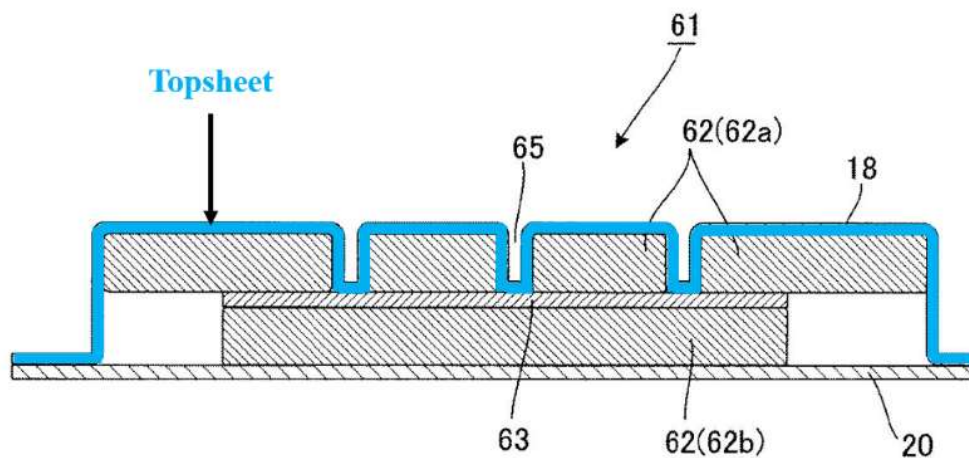
b. 1[a]: “a fluid permeable top sheet”

153. Nakazawa-'190 describes a fluid permeable topsheet (e.g., topsheet 18).

154. Nakazawa-'190 describes that absorbent article 1 “comprises ... a topsheet 18 made at least partially of a liquid-permeable material and disposed so as to cover the top surface of the absorbent material.” EX1008-Nakazawa-'190, [0018]; *see also* Abstract (“the absorbent article 1 of the present invention comprises an absorbent material 22, a top sheet 18 made at least partially of a liquid-permeable material and disposed so as to cover the top surface of the absorbent material”), [0074] (“the top sheet 18 is disposed on the top surface of the first absorbent material 62a”), [0084], [0116]-[0120], Figure 14A (item 101), claims 1 and 3.

155. I have annotated Figure 14A below to show the topsheet.

[Fig. 14A]



EX1008-Nakazawa-'190, Figure 14A.

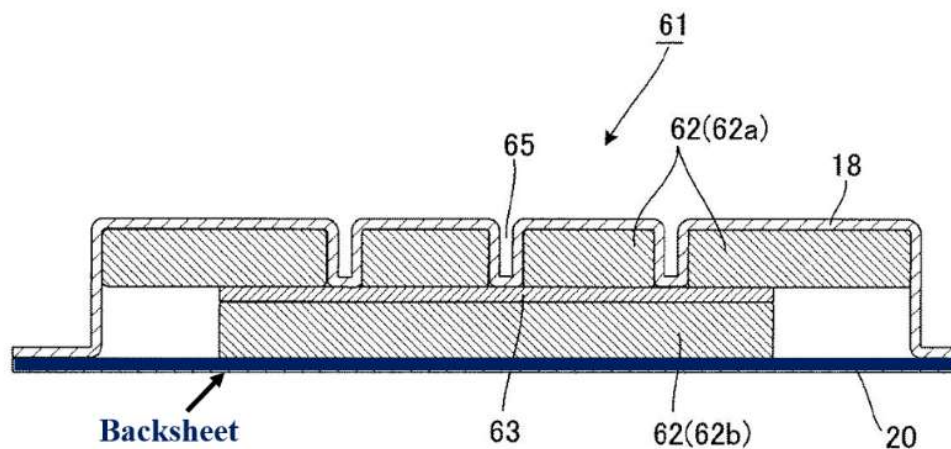
c. 1[b]: “a fluid impermeable backsheet”

156. Nakazawa-'190 describes a fluid impermeable backsheet (e.g., backsheet 20).

157. Nakazawa-'190 describes that absorbent article 1 has “a back sheet 20 made of a liquid-impermeable material.” EX1008-Nakazawa-'190, Abstract, [0074] (same). Nakazawa-'190 explains the “back sheet is a sheet disposed so as to cover the back surface of the absorbent material, for example, the surface located on the wearer's clothed side when the absorbent article is used as a disposable diaper. The back sheet is composed of a liquid-impermeable material to prevent leakage of excretory fluid such as urine to the outside.” EX1008-Nakazawa-'190, [0123]; *see also id.*, [0123]-[0126]; claims 1 and 3.

158. I have annotated Figure 14A below to show the backsheet in Nakazawa-'190.

[Fig. 14A]



EX1008-Nakazawa-'190, Figure 14A.

d. 1[c]: “an absorbent core enclosed between said topsheet and said backsheet”

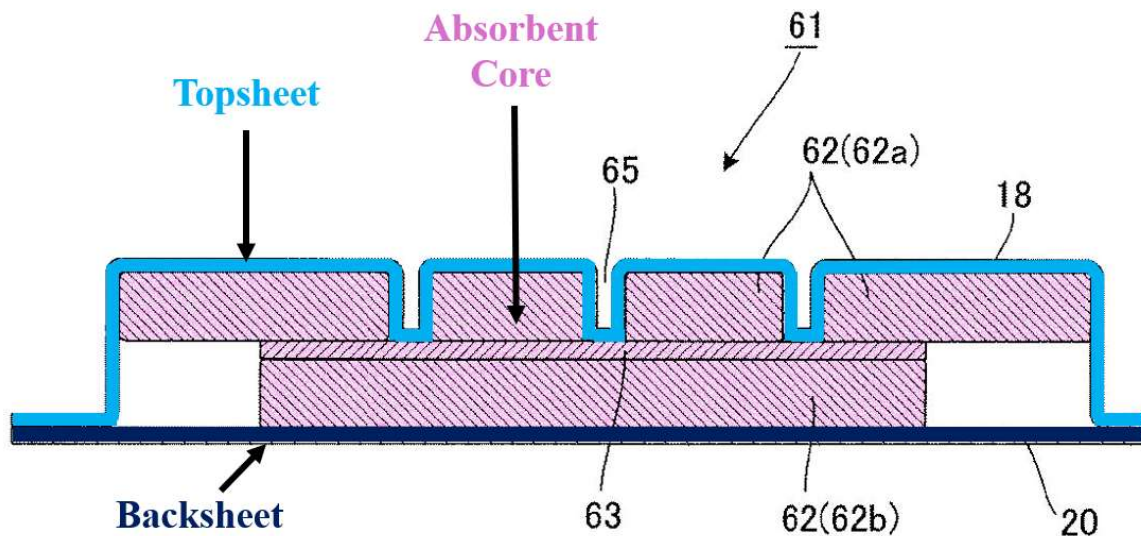
159. Nakazawa-'190 discloses an absorbent core (e.g., absorbent material 62, diffusion sheet 63) enclosed between said topsheet (e.g., topsheet 18) and said backsheet (e.g., backsheet 20).

160. Nakazawa-'190 explains, “an absorbent article 61 comprising an absorbent material 62, a top sheet 18 made at least partially of a liquid-permeable material and disposed so as to cover the top surface of the absorbent material 62, and a back sheet 20 made of a liquid-impermeable material and disposed on the back surface of the absorbent material 62.” EX1008-Nakazawa-'190, [0074]; *see also id.*, [0036] (“each absorbent material ... was interposed by a top sheet and a back sheet.”); *see, e.g., id.*, [0181], Figure 14A, claims 1-3, 5, 6. Nakazawa-'190 explains the “absorbent material is inserted between the top sheet and the back sheet and secured between the top sheet and the back sheet by sealing the perimeter of the top sheet and the back sheet.” EX1008-Nakazawa-'190, [0039]; *id.*, [0040] (“In the first absorbent article, the absorbent material is formed with hole portions penetrating from the top surface to the back surface, a top sheet is disposed on the top surface of the absorbent material, and a diffusion sheet with higher liquid permeability than the absorbent material is disposed on the back surface of the absorbent material to cover the region including the openings in the hole portions.”).

161. Nakazawa-'190 describes that “a diffusion sheet 63 with higher liquid permeability than the first absorbent material 62a is disposed between the first absorbent material 62a and the second absorbent material 62b.” EX1008-Nakazawa-'190, [0074], [0084] (“the diffusion sheet 63 is exposed in the hole portions 65 and the top sheet 18 and the diffusion sheet 63 are joined together at the openings in the hole portions 65 on the back surface of [the] first absorbent material 62a.”), Figure 14A.

162. As shown in Figure 14A, annotated below, the absorbent material 62 and diffusion sheet 63 are arranged between the topsheet 18 and the backsheet 20.

[Fig. 14A]



EX1008-Nakazawa-'190, Figure 14A.

- e. 1[d]: “said absorbent core comprising, a first absorbent layer having an opening that passes through the first absorbent layer from one major

**surface to an opposing major surface and
therebetween the opening is surrounded by a closed
periphery of first absorbent layer”**

163. Nakazawa-'190 discloses a first absorbent layer having an opening (e.g., hole portion 65) that passes through the first absorbent layer (e.g., first absorbent material 62a) from one major surface to an opposing major surface and therebetween the opening is surrounded by a closed periphery of first absorbent layer.

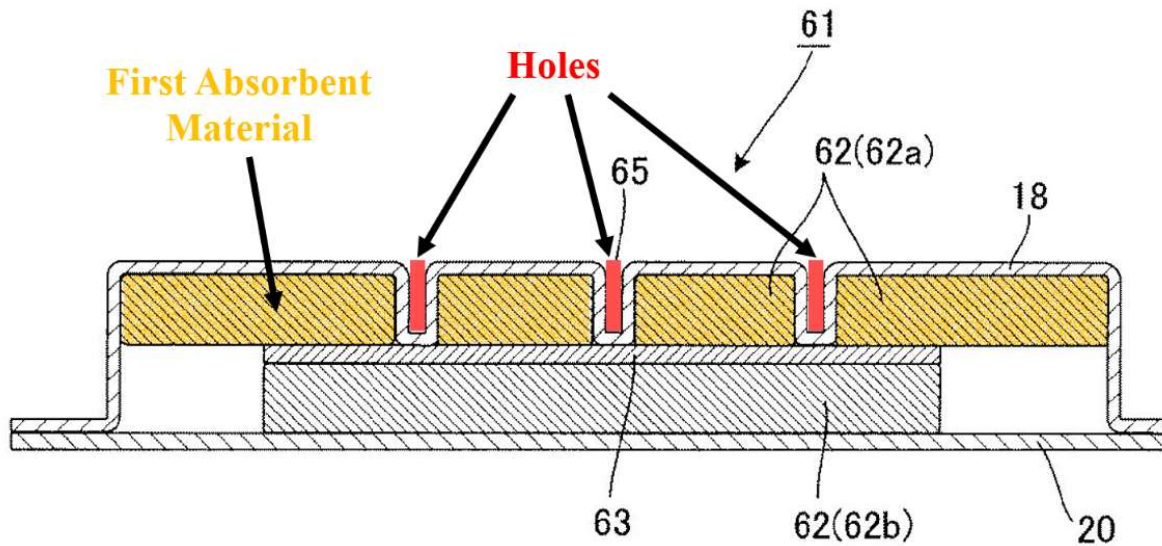
164. Nakazawa-'190 discloses that the absorbent article as shown in Figure 14A has hole portions 65 that “penetrate[] from the top surface to the back surface of the first absorbent material 62a.” EX1008-Nakazawa-'190, [0074]. Nakazawa-'190 also states, “In the absorbent articles shown in Fig. 14A and Fig. 14B, the top sheet 18 covers ... the inner surfaces of the hole portions 65 in the first absorbent material 62a.” *Id.* [0084]; *see also id.* (“the top sheet 18 and the diffusion sheet 63 are joined together at the openings in hole portions 65 on the back surface of first absorbent material 62a”), Figure 14A, claims 1-7.

165. Nakazawa-'190 explains “[b]y forming hole portions in the longitudinal direction in this way, excretory fluid can be readily diffused and efficiently absorbed when excretory fluid is absorbed from the back surface of the absorbent material via the diffusion sheet placed on the back surface of the absorbent material.” EX1008-Nakazawa-'190, [0050]; *see also id.*, [0047], [0040].

166. I have annotated Figures 11 and 14A below to show the hole portions

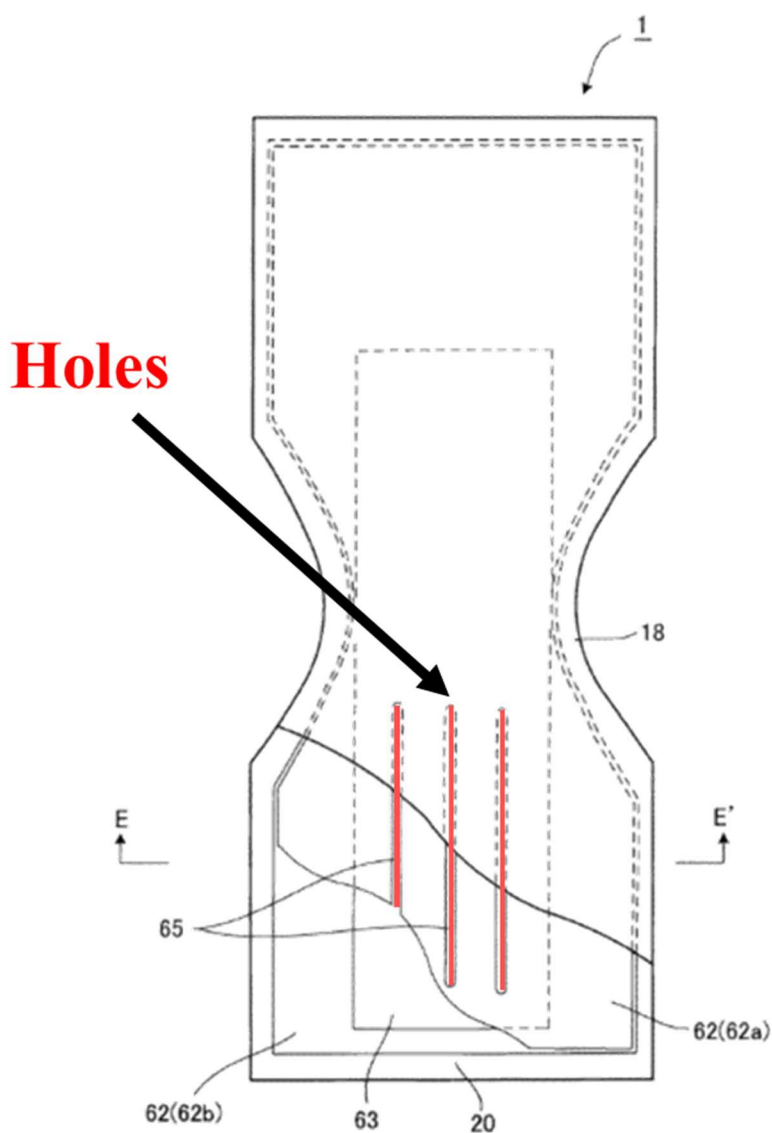
65.

[Fig. 14A]



EX1008-Nakazawa-'190, Figure 14A.

[Fig. 11]



EX1008-Nakazawa-'190, Figure 11.

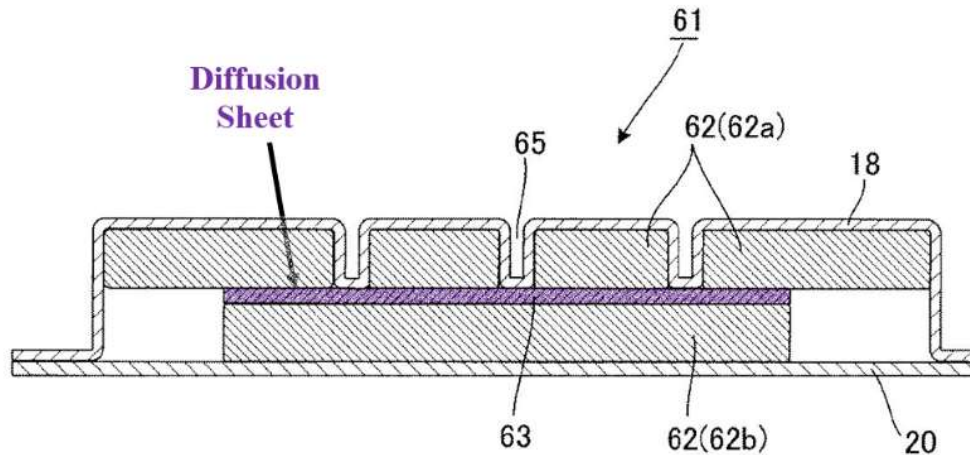
f. 1[e]: “said absorbent core comprising . . . a fluid flow control structure”

167. Nakazawa-'190 discloses a fluid flow control structure (e.g., diffusion sheet 63).

168. Nakazawa-'190 explains that "diffusion sheet has higher liquid permeability than the absorbent material, and when excretory fluid flows into the hole portions of the absorbent material, it can permeate the diffusion sheet and diffuse faster than it can be absorbed by the absorbent material." EX1008-Nakazawa-'190, [0061]. Nakazawa-'190 further states "a diffusion sheet 63 with higher liquid permeability than the first absorbent material 62a is disposed between the first absorbent material 62a and the second absorbent material 62b..." *Id.* Nakazawa-'190 explains that a diffusion sheet can be made of a nonwoven fabric or porous plastic film. *Id.* at [0062]. "The main fibers and resin that fibers and resin that constitute the diffusion sheet can be a polyolefin such as polypropylene or polyethylene, a polyamide such as polyester or nylon, an acrylic, vinylon, or composite fibers or a composite resin of these." *Id.* "In the case of a nonwoven fabric, a diffusion sheet can be obtained by forming these fibers using thermal bonding, resin bonding, some other chemical bonding method, needle punching, or the spunlace method." *Id.*, Abstract, [0074], [0172], Figure 14A, claims 1-7; *see also id.*, [0012], [0013], [0015], [0018].

169. I have annotated Figure 14A below to show the diffusion sheet in Nakazawa-'190.

[Fig. 14A]



EX1008-Nakazawa-'190, Figure 14A.

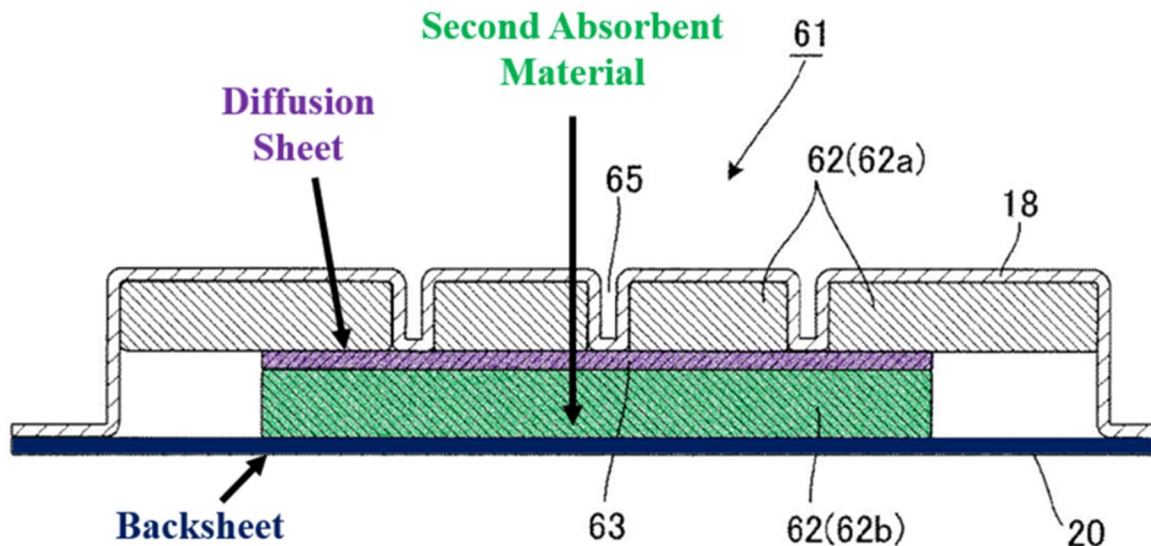
- g. 1[f]: “said absorbent core comprising . . . a second absorbent layer arranged between the fluid flow control structure and the fluid impermeable backsheet”**

170. Nakazawa-'190 discloses an absorbent core comprising a second absorbent layer (e.g., second absorbent material 62b) arranged between the fluid flow control structure (e.g., diffusion sheet 63) and the fluid impermeable backsheet (e.g., backsheet 20).

171. Nakazawa-'190 discloses “a diffusion sheet 63 . . . is disposed between first absorbent material 62a and the second absorbent material 62b.” EX1008-Nakazawa-'190, [0074]. Nakazawa-'190 also explains there is “a back sheet 20 . . . disposed on the back surface of the absorbent material 62.” EX1008-Nakazawa-'190, [0074]; *see also id.*, [0079], [0081], claims 3, 5, 6.

172. I have annotated Figure 14A below to show the second absorbent material 62b (i.e., a second absorbent layer) is arranged between the diffusion sheet 63 (i.e., the fluid flow control structure) and the backsheet 20. *See id.*, Figure 14A.

[Fig. 14A]



EX1008-Nakazawa-'190, Figure 14A.

- h. 1[g]: “wherein the fluid flow control structure is arranged between said first absorbent layer and said backsheet”**

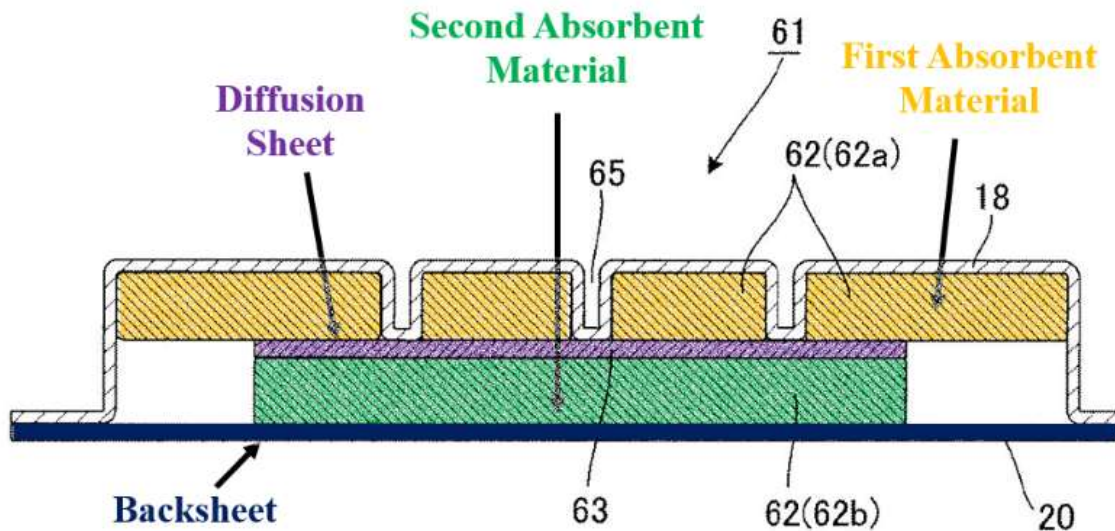
173. Nakazawa-'190 discloses an absorbent core comprising a second absorbent layer (e.g., second absorbent material 62b) arranged between the fluid flow control structure (e.g., diffusion sheet 63) and the fluid impermeable backsheet (e.g., backsheet 20).

174. Nakazawa-'190 discloses “a diffusion sheet 63 ... is disposed between the first absorbent material 62a and the second absorbent material 62b,” and further

discloses, “a back sheet 20 ... disposed on the back surface of the absorbent material 62.” EX1008-Nakazawa-'190, [0074]; *see also id.*, [0079], [0081], claims 3, 5, 6.

175. I have annotated Figure 14A below to show that the second absorbent material 62b (i.e., a second absorbent layer) is arranged between the diffusion sheet 63 (i.e., the fluid flow control structure) and the backsheet 20. *See id.*, Figure 14A.

[Fig. 14A]



EX1008-Nakazawa-'190, Figure 14A.

- i. **1[h]: “said fluid flow control structure being a layered structure comprising a non-perforated fibrous polymeric layer and a first perforated polymeric layer”**

176. Nakazawa-'190 and Glaug-'753 together disclose a fluid flow control structure (e.g., Nakazawa-'190 diffusion sheet 63; Glaug-'753 fluid acquisition system 34) being a layered structure comprising a non-perforated fibrous polymeric

layer (e.g., Glaug-'753 lower most layer 64) and a first perforated polymeric layer (e.g., Nakazawa-'190 diffusion sheet 63; Glaug-'753 apertured polymeric film 62).

177. Nakazawa-'190 discloses a single layer fluid flow control structure, its diffusion sheet 63. Nakazawa-'190 describes that the diffusion sheet as having “higher liquid permeability than the absorbent material, and when excretory fluid flows into the hole portions of the absorbent material, it can permeate the diffusion sheet and diffuse faster than it can be absorbed by the absorbent material.” EX1008-Nakazawa-'190, [0061]. Nakazawa-'190 also describes how a porous plastic film can be used for the diffusion sheet. *Id.*, [0068]. It explains that the pores in such a film “should be funnel-shaped, that is, the size of the opening in the pores decreases progressively from the front surface to the back surface of the porous plastic film. This configuration allows excretory fluid to pass through the pores of the porous plastic film and reduces liquid backflow.” *Id.*

178. Nakazawa-'190 does not disclose a second, non-perforated fibrous layer for the fluid flow control structure as the fluid flow control structure is described in the '138 patent. As I explain below, in Section X.E.1., Nakazawa-'190 describes a second, non-perforated fibrous layer based on how Patent Owner is asserting the claim against the accused First Quality product.

- **Glaug-'753 discloses a two layer fluid flow control structure**

179. Glaug-'753 discloses a two-layer fluid flow control structure with a non-perforated fibrous polymeric layer and a perforated polymeric layer. Glaug-'753 describes an absorbent article, which comprises a “fluid acquisition system 34” with “at least two layers disposed over each other.” EX1006-Glaug-'753, 8:1-2 (“[T]he fluid-acquisition system basically comprises at least two layers disposed over each other.”), Figure 2, claim 1 (“said fluid acquisition system comprising a first fluid acquisition layer and a second fluid acquisition layer...said first fluid acquisition layer comprising a three-dimensional apertured film...including a large number of generally uniformly sized tapering apertures...said second fluid acquisition layer comprising a fibrous, fluid pervious material”); *see also id.*, Abstract (“The fluid acquisition system comprises a first fluid acquisition layer formed of apertured polymeric, e.g., three dimensional, film and a second fluid acquisition layer, e.g., a fibrous material, secured together and located between the top-sheet and the core...the fluid acquisition system serves to facilitate the transference of fluid into the core, e.g., spread out the fluid over the core and providing it to the core at a rate at which the materials of the core can accommodate”), 3:29-40, 4:5-8 (“The fluid acquisition system cooperates with the core to facilitate the transference of fluid, e.g., urine, into the core for absorption and retention in the core even under repeated insults.”), 4:35-39, 4:58-60 (“The fluid-

acquisition system 34 is located on top of the core and under the top-sheet to facilitate the passage of liquid waste into the core for absorption thereby.”).

180. Glaug-’753 explains that the fluid acquisition system “includes at least two layers of materials which are constructed such that they cooperate to manage, transport, accommodate and/or direct high volumes and high flow rates of urine or other body fluid received from the top sheet target zone into the absorbent core 36 at a rate that the core can handle, despite multiple insults of such fluid.” EX1006-Glaug-’753, 6:11-18; *see also id.*, 8:1-2, 9:17-49.

181. Glaug-’753 explains that “the uppermost of the layers making up the fluid acquisition system 34 comprises an apertured polymeric film 62.” EX1006-Glaug-’753, Abstract. Glaug-’753 explains that the apertures in the polymeric film, like the apertures in Nakazawa-’190’s film are “preferably three dimensional in nature.” *Id.*, 8:3-5. Glaug-’753 explains the “myriad of very tiny conically shaped apertures, which taper in the direction from the top sheet 32 towards the core 36 ... result[] in a faster and higher fluid volume intake into the diaper and a slower and lower fluid volume output after the diaper has been saturated with fluid and exposed to compressive forces.” *Id.*, 9:23-34, claim 1.

182. Glaug-’753 further explains that “[t]he lowermost layer making up the fluid acquisition system 34 is designated by the reference number 64 and can be any type of *fibrous* material.” EX1006-Glaug-’753, Abstract (emphasis added). The

“fluid experiences some lateral distribution both transversely and longitudinally in the plane making up the layer 64 due to the fiber orientation of that layer in the machine direction.” *Id.*, 9:34-39. Glaug-’753 discloses this fibrous material can include “bi-component fibers are made of a polypropylene inner core and polyethylene outer sheath,” which a person of ordinary skill in the art would understand is a fibrous **polymeric** layer. *Id.*, 8:18-29; *see also id.*, 4:1-4, claims 1, 15-17; *see also id.*, Figure 2.

183. I have annotated Figure 2 below to show the two layers of Glaug-’753’s fluid acquisition system.

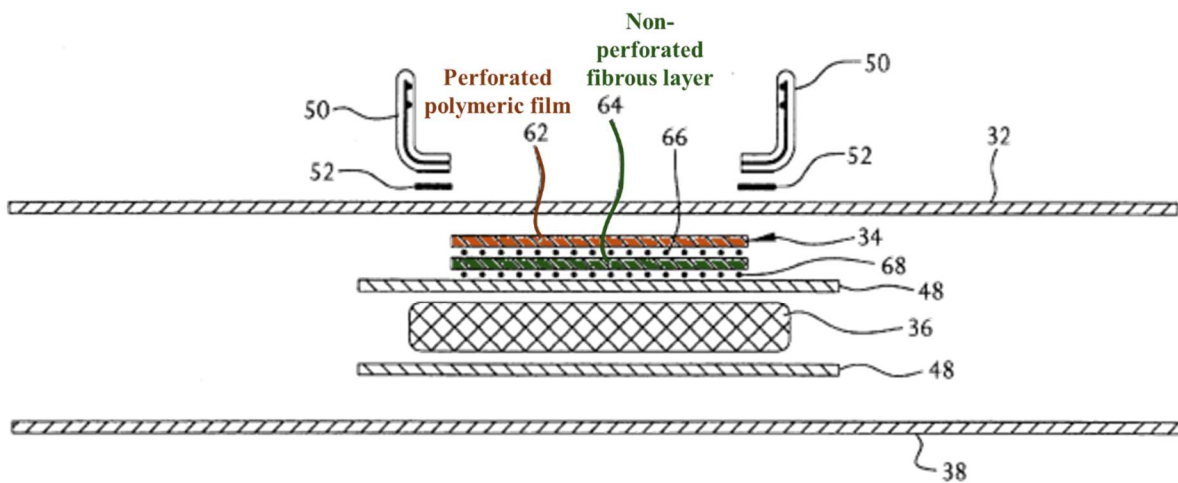


FIG. 2

EX1006-Glaug-’753, Figure 2.

- **A person of ordinary skill in the art would have been motivated to modify or combine Nakazawa-'190 in view of Glaug-'753**

184. In view of the descriptions in Nakazawa-'190 and Glaug-'753, I describe above, a person of ordinary skill in the art would have been motivated to modify Nakazawa-'190 in view of Glaug-'753 as follows:

- Nakazawa-'190's absorbent article would have been modified to include the lower nonperforated fibrous layer 64 below Nakazawa-'190's diffusion sheet 63; or
- Nakazawa-'190's absorbent article would have been modified to replace diffusion sheet 63 with Glaug-'753's two layer fluid acquisition system 34

Below, I explain why a person of ordinary skill in the art would have been motivated to combine Nakazawa-'190 and Glaug-'753 in this manner with a reasonable expectation of success.

185. As a preliminary matter, a person of ordinary skill in the art would have understood that Nakazawa-'190 and Glaug-'753 are in the same field as the '138 patent because they all relate to the structure and design of absorbent articles. A person of ordinary skill in the art would have also understood that Nakazawa-'190 and Glaug-'753 are reasonably pertinent to solving the problems addressed in the '138 patent—the rapid absorption and spreading/distribution of fluid (EX1001-USP138, '138 Patent)—with the same types of solutions—e.g., adding a particular fluid flow control structure for rapid acquisition and distribution of fluid.

186. A person of ordinary skill in the art would have been motivated to combine the teachings of Nakazawa-'190 with Glaug-'753 for many reasons and would have had a reasonable expectation of success.

187. Before the '138 patent, fluid flow control structures, which can also be commonly called acquisition and/or distribution layers, were very well known. *See, e.g.,* EX1006-Glaug-'753, 1:21-23. A person of ordinary skill in the art would have known that absorbent layers were very good at storing fluid, but they typically store fluid at the location the fluid encounters the absorbent layer. *Id.* at 1:50-2:2. Absorbent layers also were known to take time to absorb fluid. *Id.* Those in the field knew about how acquisition/distribution layers could move fluid quickly away from a user's body, faster than the fluid could be absorbed, and also distribute the fluid more evenly to different areas of the absorbent layer. *Id., see also* EX1009-White2003, Table 1 (describing acquisition / distribution layers introduced in the 1990s), 4 (describing "an acquisition and transport layer" as a "building block" of "current absorbent products"); EX1010-Ajmeri2010, 88 ("acquisition/distribution layers made with through-air bonded nonwovens are considered by hygiene product manufacturers to be particularly efficient in attaining improved penetration and preventing rewetting"), 92 ("[t]he ADL provides more rapid liquid acquisition (minimizing flooding into the target zone), and more rapid transport and thorough distribution of the fluid into the remainder of the absorbent region."); EX1011-

Gupta2002, 373 (“the current absorbent structures, such as diaper and incontinence pads, are composed of three or four elements” including an “acquisition/distribution layer”). A person of ordinary skill in the art would have also known that fluid acquisition systems frequently include more than one layer. *See, e.g.*, EX1018-White2000, Figure 2. For example, these layers are sometimes referred to as an acquisition layer and a distribution or transport layer. EX1018-White2000, 44.14 (describing the function of the acquisition layer as that “fluid [must] instantaneously [be] transferred through the top sheet must be absorbed as quickly by capillary forces” and that for the “wicking or transport layer, the important characteristics are wettability, pore size and pore distribution.”).

188. Both Nakazawa-’190 and Glaug-’753 describe the advantages of having of an acquisition layer, especially an acquisition layer that has perforations formed as three-dimensional apertures that channel fluid to an absorbent article further away from a user’s body. EX1008-Nakazawa-’190, [0012], [0013]; EX1006-Glaug-’753, 9:24-27. They also both explain how the acquisition layer helps make the transfer of the liquid to the absorbent layers faster. EX1008-Nakazawa-’190, [0061], [0068]; EX1006-Glaug-’753, 2:41-48. The only difference between Nakazawa-’190’s single layer perforated diffusion sheet and Glaug-’753’s two layer fluid acquisition system is that Glaug-’753 discloses having a fibrous, non-

perforated layer in addition to the perforated film. EX1006-Glaug-'753, Abstract, 4:1-4, 8:3-5, 8:18-20, 9:19-27, claims 1, 15-17.

189. Glaug-'753 describes the benefits of including a non-perforated fibrous layer in addition to a perforated polymeric layer in an absorbent article. Glaug-'753 explains that its two layer fluid flow control structure (the fluid acquisition system 34) provides several improvements over known acquisition layers. EX1006-Glaug-'753, 9:30-34. First, Glaug-'753 describes that the top perforated layer 62 provides “faster and higher fluid volume intake into” the disclosed absorbent article (a diaper). EX1006-Glaug-'753, 9:30-34. Glaug-'753 explains this is due to the perforated layer having “three dimensionally shaped apertures directed inwardly toward the core 36.” *Id.*, 9:24-27. Glaug-'753 also explains that the lower non-perforated fibrous layer provides “lateral distribution both transversely and longitudinally” of fluid “due to the fiber orientation of that layer.” *Id.*, 9:34-39. The two layers of Glaug-'753's fluid acquisition system work together to “optimize[] the fluid penetration rate and volume into the absorbent core 36 below it, while also minimizing the fluid from exiting the diaper 20 when it is saturated and under high stress.” EX1006-Glaug-'753, 9:43-46; *see also id.*, 6:11-18 (the layers of the fluid acquisition system “cooperate to manage, transport, accommodate and/or direct high volumes and high flow rates of urine or other body fluid received from the top sheet

target zone into the absorbent core 36 at a rate that the core can handle, despite multiple insults of such fluid”).

190. These advantages and benefits would have motivated a person of ordinary skill in the art to modify Nakazawa-’190 by either adding Glaug-’753’s lower non-perforated layer to the diffusion sheet 63, or by replacing the diffusion sheet 63 with Glaug-’753’s fluid acquisition system. These changes would offer the same advantages of faster fluid penetration while reducing fluid leakage from the absorbent article, which are also goals that Nakazawa-’190 seeks to address. *See* EX1006-Glaug-’753, 9:43-46; *see also id.*, 6:11-18.; EX1008-Nakazawa-’190, [0031].

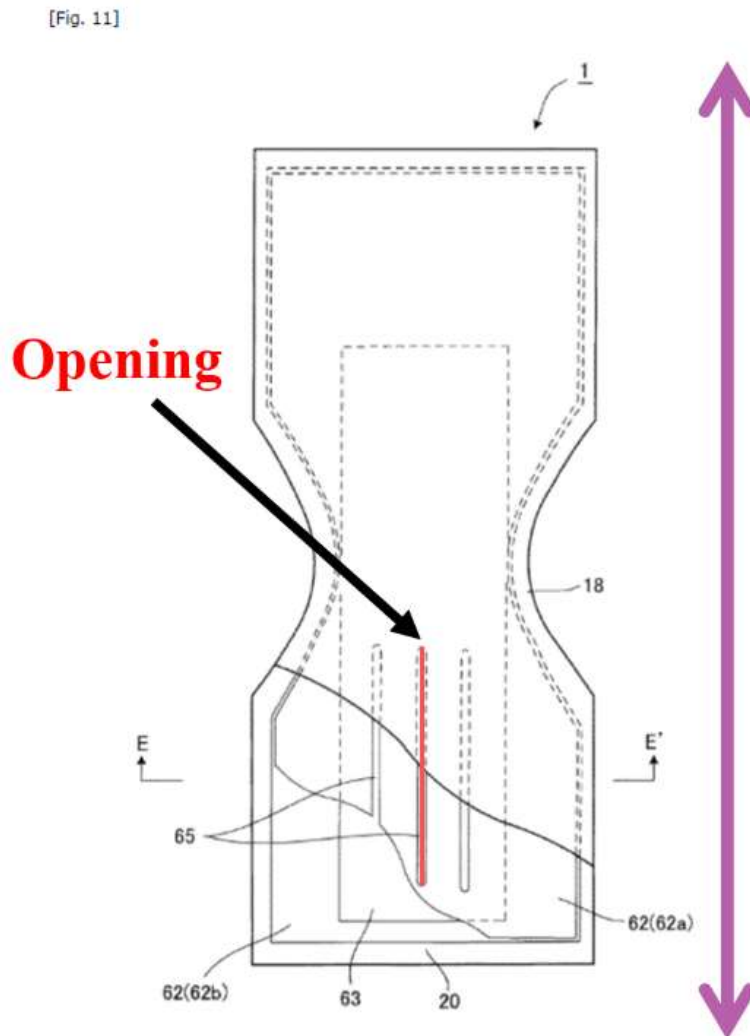
191. A person of ordinary skill in the art would have also found it obvious to make the combinations I propose above for a few additional reasons. First, the proposed combinations involve the simple substitution of one known element (Glaug-’753’s two layer fluid acquisition system) for another (Nakazawa-’190’s single layer diffusion sheet) to obtain predictable results (optimized fluid acquisition and distribution). Second, the proposed combinations involve the use of a known technique (Glaug-’753’s two layer fluid acquisition system or lower non-perforated layer) to improve a similar device (Nakazawa-’190’s multi-layer absorbent article) in the same way (by improving fluid acquisition and distribution).

192. Combining Nakazawa-'190 and Glaug-'753 in the manner proposed above would have yielded predictable results and a person of ordinary skill in the art would have had a reasonable expectation of success in doing so. Nakazawa-'190 and Glaug-'753 describe similarly designed multi-layered absorbent articles. For example, both references include a fluid-permeable topsheet, a fluid-impermeable backsheet, a layer for fluid acquisition/distribution, and one or more absorbent cores. As I explain above, acquisition/distribution layers were well-known and well-understood before the '138 patent and were predictable components for multi-layered absorbent articles. Thus, Glaug-'753's fluid acquisition system or lower nonperforated layer would have been used in the Nakazawa-'190 article in the same way those components are used in Glaug-'753 itself. Combining these articles required no more than routine skill and was the simple combination of known components to yield predictable results. Thus, it is my opinion that this limitation would have been obvious in view of Nakazawa-'190 and Glaug-'753.

- j. **1[i]: “wherein the opening extends along a longitudinal center line of the absorbent article, the longitudinal center line being in parallel with the longitudinal direction of the absorbent article”**

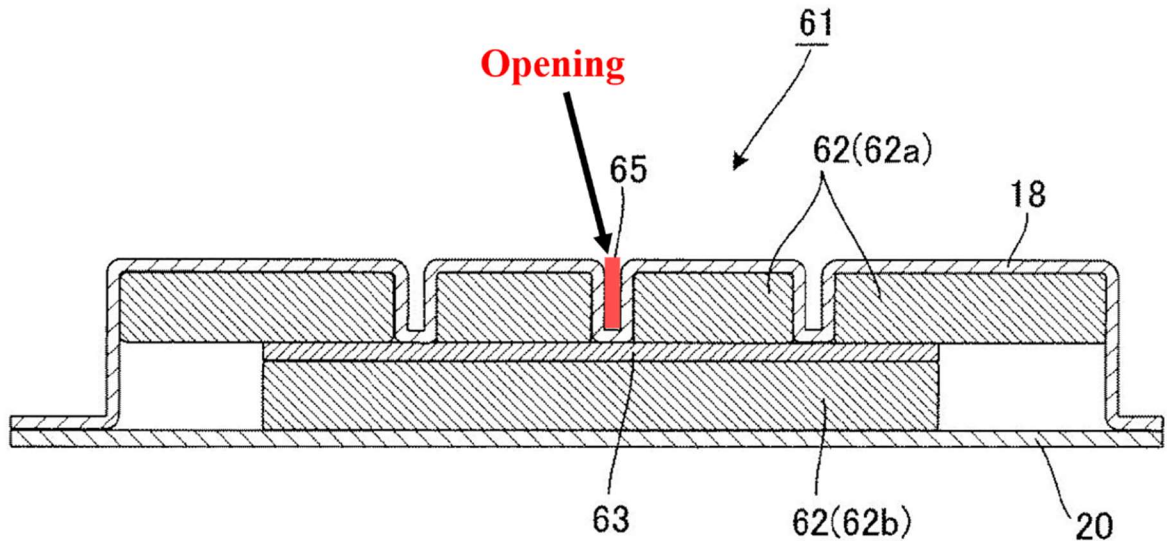
193. Nakazawa-'190 states that the opening (e.g., hole portion 65) extends along a longitudinal center line of the absorbent article, the longitudinal center line being parallel with the longitudinal direction of the absorbent article.

194. I have annotated Figure 11 and 14A below to show how the center opening 65 extends along a longitudinal direction in the center of the absorbent article. *See, e.g.*, EX1008-Nakazawa-'190, Figures 11 and 14A; *see also id.*, [0093] (“The first hole portions and second hole portions may be formed so that they are in the same positions near the center of the width direction, which is the urination site.”).



EX1008-Nakazawa-'190, Figure 11.

[Fig. 14A]



EX1008-Nakazawa-'190, Figure 14A.

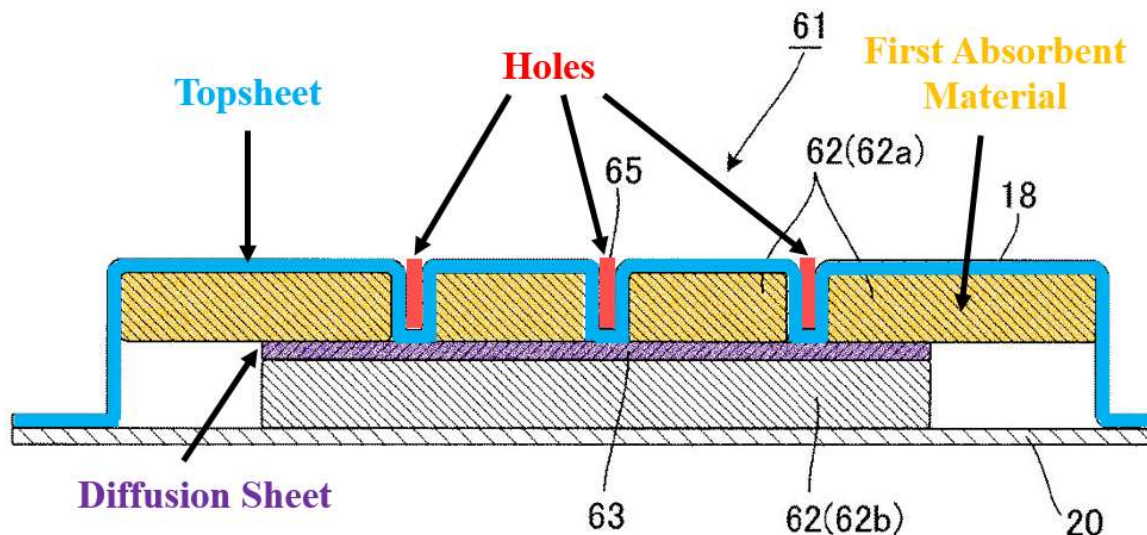
- k. 1[j]: “the fluid permeable top sheet is in direct contact with the fluid flow control structure via the opening.”**

195. Nakazawa-'190 discloses the fluid permeable topsheet (e.g., topsheet 18) is in direct contact with the fluid flow control structure (e.g., diffusion sheet 63) via the opening (e.g., hole portions 65).

196. Nakazawa-'190 describes, “the top sheet 18 covers ... the inner surfaces of the hole portions 65 in the first absorbent material 62a.” EX1008-Nakazawa-'190, [0014], [0016], [0019], [0084], [0119], Figure 14A, claims 2, 4, 7.

197. I have annotated Figure 14A below to show how the topsheet is in contact with the diffusion sheet via the openings.

[Fig. 14A]



EX1008-Nakazawa-'190, Figure 14A.

2. **Claim 3: “The absorbent article according to claim 1, wherein the first perforated polymeric layer is a nonwoven, a film or a film/nonwoven laminate”**

198. It is my opinion that Nakazawa-'190 in view of Glaug-'753 discloses the additional limitation required by claim 3.

199. Nakazawa-'190 in view of Glaug-'753 discloses a first perforated polymeric layer (e.g., Nakazawa-'190 diffusion sheet 63; Glaug-'753 apertured polymeric film 62) that is a nonwoven, a film or a film/nonwoven laminate.

200. First, Nakazawa-'190 describes the diffusion sheet “can be made of a nonwoven fabric or porous plastic film.” EX1008-Nakazawa-'190, [0062]. For example, Nakazawa-'190 explains, “[t]he main fibers and resin that constitute the

diffusion sheet can be a polyolefin such as polypropylene or polyethylene, a polyamide such as polyester or nylon, an acrylic, vinylon, or composite fibers or a composite resin of these.” *Id.*

201. Second, Glaug-’753 also describes an “apertured [i.e., perforated] polymeric layer (film) 62 of the fluid acquisition system.” EX1006-Glaug-’753, 8:1-7. Glaug-’753 notes that “[o]ne particularly suitable material is available from Tredegar Film Products of Terra Haute, Ind. under the trade designation C120 and basically comprises a polyethylene film apertured like that shown in U.S. Design Pat. No. D362,120.” *Id.*, 8:7-12. Glaug-’753 describes that “[o]ther three dimensional polymeric apertured films, such as those in the patents discussed above, can be utilized to form the first fluid acquisition layer 62.” *Id.*, 8:12-15. “In fact, for some applications two dimensional apertured films, like those of the prior art may be used for the layer 62.” *Id.*, 8:15-17.

202. For the reasons that I explained above in Section X.B.1.i, a person of ordinary skill in the art would have been motivated to modify Nakazawa-’190 in view of Glaug-’753 and would have had a reasonable expectation of success in doing so.

3. **Claim 4: “The absorbent article according to claim 1, the first perforated polymeric layer is a three-dimensionally formed layer having penetrating apertures extending from a first surface of the first perforated polymeric layer towards a second surface of the first perforated polymeric layer and forming protrusions on said second surface”**

203. It is my opinion that Nakazawa-’190 in view of Glaug-’753 discloses the additional limitation required by claim 4.

204. Both Nakazawa-’190 and Glaug-’753 describe that the first perforated polymeric layer (e.g., Nakazawa-’190 diffusion sheet 63; Glaug-’753 apertured polymeric film 62) is a three-dimensionally formed layer having penetrating apertures extending from a first surface of the first perforated polymeric layer towards a second surface of the first perforated polymeric layer and forming protrusions on said second surface.

205. For example, as I discuss in Section X.B.1.f, Nakazawa-’190 describes “a porous plastic film” that may be used for the diffusion sheet. EX1008-Nakazawa-’190, [0068]. Nakazawa-’190 describes, “the shape of the pores in the porous plastic film should be funnel-shaped, that is, the size of the opening in the pores decreases progressively from the front surface to the back surface of the porous plastic film.” *Id.* Nakazawa-’190 explains that “[t]his configuration allows excretory fluid to pass through the pores of the porous plastic film and reduces liquid backflow.” *Id.*

206. Glaug-'753 describes that the fluid acquisition system 34 comprises "an apertured polymeric film 62, which is preferably three dimensional in nature." EX1006-Glaug-'753, 8:3-17; *see also id.*, Abstract, 1:32-49, 2:63-65, 3:67-4:1, 8:8-15, 9:2-5, claims 20, 21. Glaug-'753 explains that the "apertured film 62 includes a myriad of very tiny conically shaped apertures, which taper in the direction from the topsheet 32 towards the core 36. This arrangement results in a faster and higher fluid volume intake into the diaper and a slower and lower fluid volume output after the diaper has been saturated with fluid and exposed to compressive forces." EX1006-Glaug-'753, 9:24-34; *see also id.*, 6:11-18; *see also*, claims 20, 21.

207. For similar reasons that I provide above in my analysis of claim 1, limitation [h], a person of ordinary skill in the art would have found it obvious to modify Nakazawa-'190 by replacing the diffusion sheet with Glaug-'753's two-layer fluid acquisition system, or by adding Glaug-'753's lower non-perforated layer to Nakazawa-'190's diffusion sheet 63, and would have reasonably expected success. It likewise would have been obvious and a person of ordinary skill in the art would have reasonably expected success to use a three-dimensionally formed layer as recited in claim 4 for the first perforated layer because both Nakazawa-'190 and Glaug-'753 explain that such material is preferred and provides fluid acquisition and retention benefits. EX1008-Nakazawa-'190, [0068]; EX1006-Glaug-'753, 9:16-40.

4. Claim 5: “The absorbent article according to claim 4, wherein the first perforated polymeric layer is arranged with said second surface facing the non-perforated fibrous polymeric layer.”

208. Nakazawa-’190 as modified by Glaug-’753 in the manner described above in limitation 1[h] discloses that the first perforated polymeric layer (e.g., Nakazawa-’190 diffusion sheet 63; Glaug-’753 apertured polymeric film 62) is arranged with said second surface facing the non-perforated fibrous polymeric layer (Glaug-’753 lower most layer 64). In this arrangement, the protrusions from the perforated layer are facing toward the non-perforated fibrous layer.

209. Glaug-’753 describes that the fluid acquisition system 34 has “an apertured polymeric film 62, which is preferably three dimensional in nature.” EX1006-Glaug-’753, 8:3-7. Preferably, “the three dimensionally shaped apertures [are] directed inwardly towards the core.” *Id.*, 9:24-27. In this configuration, the second surface (i.e., the surface towards which the conically shaped apertures taper) faces the non-perforated polymeric layer 64, which is disposed between the perforated layer 62 and the core 36. *Id.*, 9:27-30, claim 21.

210. For similar reasons that I provide above in my analysis of claim 1, limitation [h] and Claim 4, a person of ordinary skill in the art would have found it obvious to modify Nakazawa-’190 by replacing the diffusion sheet with Glaug-’753’s two-layer fluid acquisition system, or by adding Glaug-’753’s lower

non-perforated layer to Nakazawa-'190's diffusion sheet 63, and would have reasonably expected success.

5. Claim 20: "The absorbent article according to claim 1, wherein the basis weight of the non-perforated fibrous polymeric layer is from 20-120 gsm."

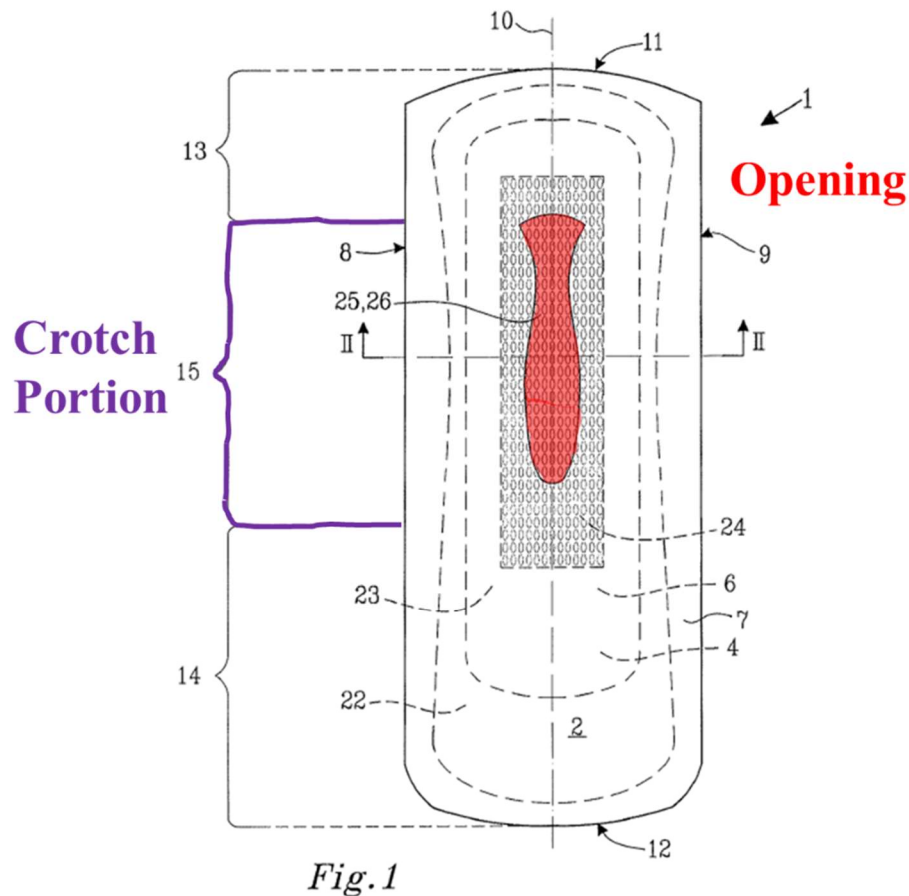
211. Nakazawa-'190 and Glaug-'753 disclose an absorbent article wherein the basis weight of the non-perforated fibrous polymeric layer is from 20-120 gsm. Glaug-'753 explains that the "lower layer 64" is made of "**20 gsm**/70mm through air bonded bicomponent fibers adhered on top of the absorbent core." EX1006-Glaug-'753, 8:44-46 (emphasis added). Glaug-'753 also describes "[a] higher basis weight acquisition layer 64, e.g., **50 gsm**/70 mm thermal bonded polypropylene fibers with variety of fiber material combinations" (EX1006-Glaug-'753, 8:47-48) (emphasis added) and that the "lower layer 64 may be in the range of **10-50 gsm**/20-230 mm through air bonded bicomponent fibers." EX1006-Glaug-'753, 8:49-52 (emphasis added).

212. For similar reasons that I provide above in my analysis of claim 1, limitation 1[h], a person of ordinary skill in the art would have found it obvious to modify Nakazawa-'190 by replacing the diffusion sheet with Gluag-'753's two-layer fluid acquisition system, or by adding Glaug-'753's lower non-perforated layer, which has a basis weight from 20-120 gsm, and would have reasonably expected success at making this modification.

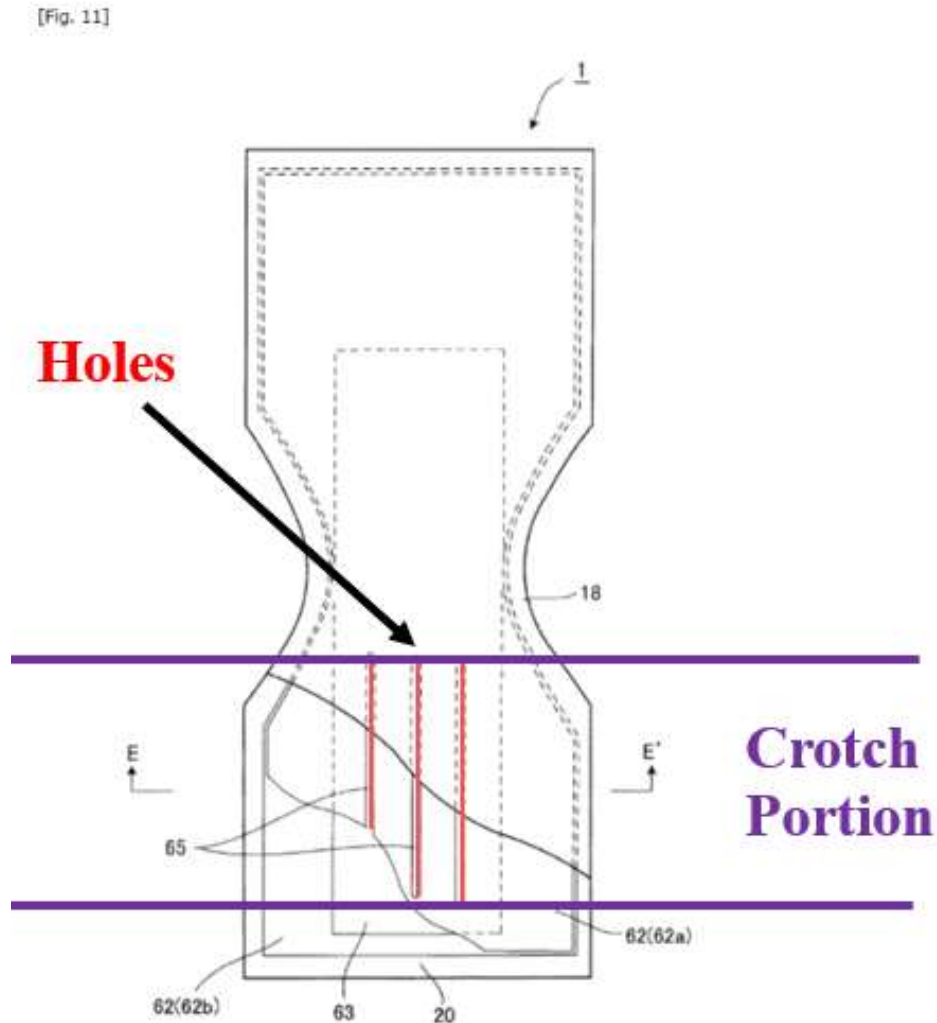
6. Claim 21: “The absorbent article according to claim 1, wherein the opening extends through the entire crotch portion of the absorbent article.”

213. Nakazawa-'190 discloses an opening (e.g., hole portion 65) that extends through the entire crotch portion of the absorbent article.

214. The '138 patent states that Figure 1 shows the opening in the crotch portion 15 of the absorbent article:



215. I have annotated Figure 11 from Nakazawa-'190 to show how the hole portion 65 also extends through the entire crotch portion of the absorbent article. See also EX1008-Nakazawa-'190, [0089].



EX1008-Nakazawa-'190, Figure 11.

7. **Claim 22: “The absorbent article according to claim 1, wherein the fluid permeable top sheet is not perforated.”**

216. Nakazawa-'190 discloses a fluid permeable topsheet (e.g., topsheet 18) that is not perforated.

217. Nakazawa-'190 describes that "a woven fabric, nonwoven fabric, or porous film can be used as the liquid-permeable materials constituting the top sheet." EX1008-Nakazawa-'190, [0117]. Nakazawa-'190 does not describe the topsheet 18 as being perforated. *See generally id.* Further, to the extent that the Board considers "porosity" to be synonymous with "perforated," Nakazawa-'190 describes the topsheet *may* include a material that has porosity, not that it is *required*. EX1008-Nakazawa-'190, [0117]. A person of ordinary skill in the art would have therefore understood that a non-perforated topsheet could be used with the disclosed absorbent article of Nakazawa-'190.

8. Claim 24: "The absorbent article of claim 1, wherein the fluid permeable top sheet is in contact with the first absorbent layer of the absorbent core at an area other than where the opening is located."

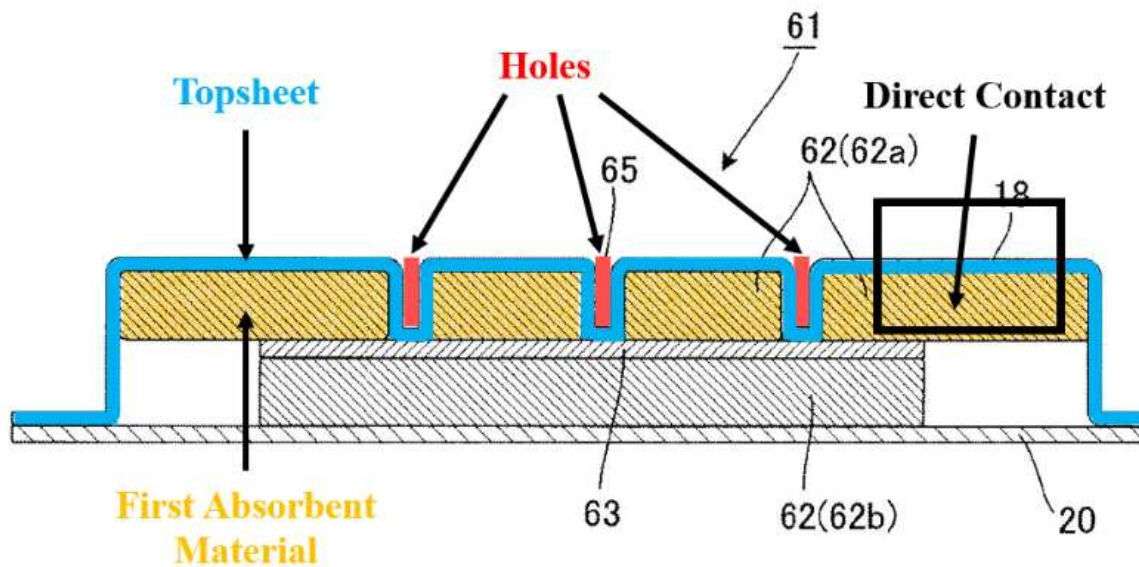
218. Nakazawa-'190 discloses a fluid permeable topsheet (e.g., topsheet 18) that is in contact with the first absorbent layer (e.g., first absorbent material 62a) of the absorbent core at an area other than where the opening is located.

219. Nakazawa-'190 describes, "the top sheet 18 is disposed on the top surface of the first absorbent material 62a." EX1008-Nakazawa-'190, [0074]. Nakazawa-'190 further explains, "In the absorbent articles shown in Fig. 14A and Fig. 14B, the top sheet 18 covers the top surface of the first absorbent material 62a,

the inner surfaces of the hole portions 65 in the first absorbent material 62a.” *Id.*, [0084]; *see also id.* Figures 14A, 14B, claims 1, 3.

220. I have annotated Figure 14A below to show where the topsheet is in contact with the absorbent material 62a.

[Fig. 14A]



EX1008-Nakazawa-'190, Figure 14A.

221. The contact between the fluid permeable topsheet and the first absorbent material—as depicted in Figure 14A—is at an area other than where the opening is located.

222. Accordingly, because Nakazawa-'190 in combination with Glaug-'753 discloses each of the elements or limitations of claim 1 and claim 24 and arranged in the same way as in claim 1 and 24, and a person of ordinary skill in the art would have been motivated to combine the teachings of Nakazawa-'190 and Glaug-'753

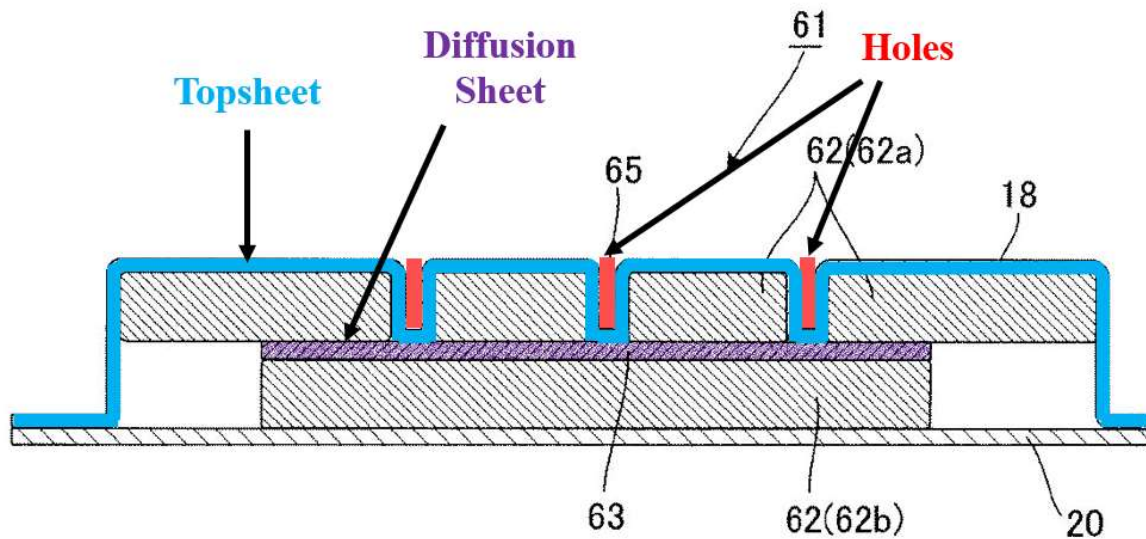
with a reasonable expectation of success, it is my opinion that Nakazawa-'190 in view of Glaug-'753 renders claim 24 obvious.

9. **Claim 25: “The absorbent article according to claim 1, wherein the fluid permeable topsheet is in contact with the fluid flow control structure via the opening, such that a cavity is formed along the longitudinal center line of the absorbent article.”**

223. Nakazawa-'190 discloses a fluid permeable topsheet (e.g., topsheet 18) that is in contact with the fluid flow control structure (e.g., diffusion sheet 63) via the opening (e.g., hole portions 65) such that a cavity is formed along the longitudinal center line of the absorbent article.

224. I have annotated Figure 14A below to show there is no material between the diffusion sheet (i.e., the fluid flow control structure) and the topsheet 18 at the hole portions 65 such that a cavity is formed along the longitudinal center line of the absorbent article. EX1008-Nakazawa-'190, Figures 14A-14B; *see also id.*, [0074] (“a hole portion 65 that penetrates from the top surface to the back surface of the first absorbent material 62a is formed in the first absorbent material 62a”).

[Fig. 14A]



EX1008-Nakazawa-'190, Figure 14A.

C. Ground III: Claim 7 Is Obvious Over Nakazawa-'190 in view of Glaug-'753 and Cohen-'429

1. Claim 7: "The absorbent article according to claim 4, wherein the average size of the apertures in the first perforated polymeric layer is 0.5-5 mm"

225. As I discussed above in Ground II, claims 1 and 4 are obvious over Nakazawa-'190 in view of Glaug-'753. It is also my opinion that Nakazawa-'190 in view of Glaug-'753 and Cohen-'429 discloses the additional limitation required by claim 7.

226. Nakazawa-'190 in view of Glaug-'753 and Cohen-'429 describes that the average size of the apertures in the first perforated polymeric layer is 0.5-5 mm.

227. The '138 patent states the “apertures in the first perforated polymeric layer may have an average size of 0.5-5 mm, measured at the smallest diameter of the apertures.” EX1001-USP138, 3:45-47. I note that in my review of the '138 patent I did not find anything in the disclosure that explained why this precise range in aperture size was critical to the invention or the functionality of the absorbent article.

228. Glaug-'753 describes that a preferred material for its apertured polymeric film 62 is “available from Tredegar Film Products of Terra Haute, Ind. under the trade designation C120 and basically comprises a polyethylene film apertured like that shown in U.S. Design Pat. No. D362,120.” EX1006-Glaug-'753, 8:7-12. Glaug-'753 does not disclose the size of the apertures in the Tredegar film.

229. However, other references from before the '138 patent disclose aperture sizes for Tredegar films. For example, Cohen-'429 describes using a “three dimensional apertured film” sold by Tredegar under the trade name Aquidry as an acquisition/distribution layer. EX1016-Cohen-429, [0032]. Cohen-'429 explains the Tredegar material has an “an average pore size of 0.3-10 mm in diameter, *preferably 0.5-5.0 mm*, and optimally 1.0-2.0 mm.” EX1016-Cohen-429, [0041] (emphasis added). Cohen-'429 explains that this pore size is “sufficiently large to enable rapid liquid acquisition.” *Id.*, [0024].

230. For the same reasons as I stated above with respect to limitation 1[h] and Claims 4-5, a person of ordinary skill in the art would have found it obvious to modify Nakazawa-'190 by replacing the diffusion sheet with Glaug-'753's two-layer fluid acquisition system and would have reasonably expected success. Further, a person of ordinary skill in the art would have been motivated to use a three-dimensional perforated polymeric layer having apertures with an average size of 0.5-5.0mm for Glaug-'753's perforated layer 62 and would have had a reasonable expectation of success in doing so. This is because Cohen-'429 explains that three-dimensional Tredegar films available before the '138 patent and known to be preferable polymeric perforated acquisition/distribution layers had an average aperture size of 0.5-5.0mm.

231. Accordingly, because Nakazawa-'190 in combination with Glaug-'753 and Cohen-'429 discloses each of the elements or limitations of claim 1, claim 4, and claim 7 and arranged in the same way as in claims 1, 4, and 7, and a person of ordinary skill in the art would have been motivated to combine the teachings of Nakazawa-'190 and Glaug-'753 and Cohen-'429, it is my opinion that because Nakazawa-'190 in combination with Glaug-'753 and Cohen-'429 renders claim 7 obvious.

D. Ground IV: Claims 1-5, 7-8, 21-22, and 24-25 Are Obvious Over Nakazawa-'190 in view of Ponomarenko-'236

232. Nakazawa-'190 and Ponomarenko-'236 render obvious claims 1-5, 7-8, 21-22, and 24-25. This combination is included to show dependent claims 2 and 8 are also obvious and as an additional or alternative mapping to Nakazawa-'190 in view of Glaug-'753. Any limitation that I have not specifically addressed in this section is disclosed by Nakazawa-'190 for the reasons I explained above in Ground II.

1. Claim 1

- a. 1[h]: “said fluid flow control structure being a layered structure comprising a non-perforated fibrous polymeric layer and a first perforated polymeric layer”**

233. Nakazawa-'190 in view of Ponomarenko-'236 discloses a fluid flow control structure (e.g., Nakazawa-'190 diffusion sheet 63; Ponomarenko-'236 sublayer 30) being a layered structure comprising a non-perforated fibrous polymeric layer (e.g., Ponomarenko-'236 acquisition layer 37 and/or additional acquisition layers) and a first perforated polymeric layer (e.g., Nakazawa-'190 diffusion sheet 63; Ponomarenko-'236 acquisition layer 36 and/or additional acquisition layer).

234. Ponomarenko-'236 has a lengthy description of sublayer 30 which “in general ... serves as ... an acquisition layer and optionally also (as) a distribution

layer, capable to acquire liquid (urine) and temporarily hold the liquid and allow it to pass, or transport it to the absorbent core underneath ... and optionally also distribute it in the X and Y direction of the sublayer (30).” EX1007-Ponomarenko-’236, 7:8-19; *see also id.*, claims 1, 7.

235. Ponomarenko-’236 explains that “the sublayer (30) herein comprises or is typically one or more acquisition layers (e.g., that can temporarily absorb fluids, like urine, and pass on or transport the fluid to the absorbent core that is in proximity to said sublayer (30).” EX1007-Ponomarenko-’236, 6:36-42. Ponomarenko-’236 further explains it is “[h]ighly preferred ... that the sublayer (30) comprises two or more (acquisition layers (e.g., a laminate of two or more layers), and that the holes (31) of the sublayer (30) are preferably formed by the (aligned) holes (31) through either the first or second or first and (part of the) second or subsequent layers.” *Id.*, 6:49-54. Ponomarenko-’236 describes that in some of the disclosed embodiments, some but not all layers of the sublayer have through holes. *Id.*, 9:18-23 (“Alternatively, two or more of the layers (36, 37) of the sublayer (30) comprise holes that form together the holes (31) of the sublayer (30). It may be beneficial to have three or more acquisition layers in the sublayer (30), so that the holes are in or through some or all of the three or more acquisition layers, fulfilling the requirements set out herein.”).

236. Ponomarenko-'236 explains that at least one layer of the sublayer “comprises typically a fibrous layer.” *Id.*, 7:24. Ponomarenko-'236 also explains that “the sublayer (30) comprise an acquisition layer (e.g., second layer 37)) of unbonded polypropylene (PP) and/or polyester, or preferably polyethylene terephthalate (PET) fibres.” *Id.*, 9:59-62. As such, it describes having both a fibrous layer and a polymeric layer, as required by the '138 patent's claims, and explains that some of these layers may have holes whereas other layers do not, thus describing an arrangement where there is a perforated polymeric layer and a non-perforated fibrous polymeric layer.

237. I have annotated Figures 6 and 7 below to show embodiments where Ponomarenko-'236 shows acquisition layer 36 is completely perforated and acquisition layer 37 remains non-perforated because the holes 31 do not extend all the way through layer 37. EX1007-Ponomarenko-'236, 7:27-28.

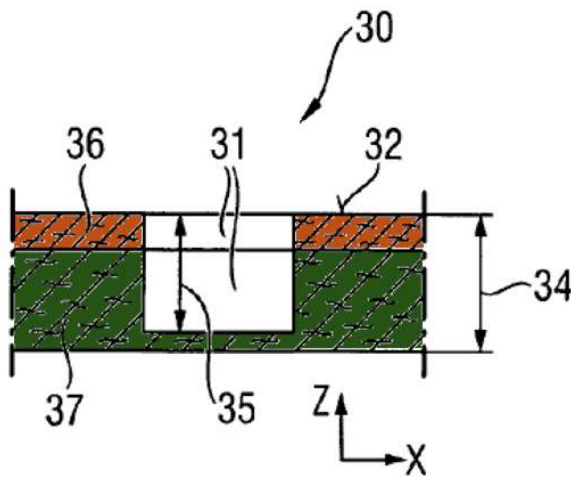


Fig. 6

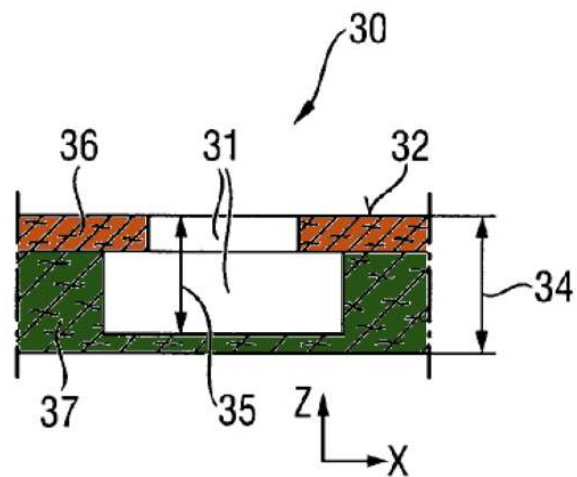


Fig. 7

EX1007-Ponomarenko-'236, Figures 6-7.

- **A person of ordinary skill in the art would have been motivated to modify or combine Nakazawa-'190 in view of Ponomarenko-'236**

238. In view of the descriptions in Nakazawa-'190 and Ponomarenko-'236 I describe above, a person of ordinary skill in the art would have been motivated to modify Nakazawa-'190 in view of Ponomarenko-'236 as follows:

- Nakazawa-'190's absorbent article would have been modified to replace diffusion sheet 63 with Ponomarenko-'236's multi-layered sublayer 30

Below, I explain why a person of ordinary skill in the art would have been motivated to combine Nakazawa-'190 and Ponomarenko-'236 in this manner with a reasonable expectation of success.

239. As a preliminary matter, a person of ordinary skill in the art would have understood that Nakazawa-'190 and Ponomarenko-'236 are in the same field as the '138 patent because they all relate to the structure and design of absorbent articles. A person of ordinary skill in the art would have also understood that Nakazawa-'190 and Ponomarenko-'236 are reasonably pertinent to solving the problems addressed in the '138 patent—the rapid absorption of fluid (EX1001-USP138, '138 Patent)—with the same types of solutions—e.g., adding a particular fluid flow control structure for rapid acquisition and distribution of fluid.

240. A person of ordinary skill in the art would have been motivated to combine the teachings of Nakazawa-'190 with Ponomarenko-'236 for a number of reasons with a reasonable expectation of success. As I discussed in Section VI.B above, before the '138 patent was filed, fluid flow control structures were already commonly used in multi-layered absorbent articles and were recognized as helping facilitate the flow of fluid into the absorbent layers and distributing the fluid to different areas of the absorbent layers.

241. As I explained above in Section X.B.1.i, Nakazawa-'190 discusses the advantages of an acquisition layer, especially a perforated layer. EX1008-Nakazawa-'190, [0012], [0013]. The difference between Nakazawa-'190's diffusion sheet and Ponomarenko-'236's sublayer is that Ponomarenko-'236

describes having additional layers, including non-perforated fibrous layers in addition to the perforated polymeric film.

242. Ponomarenko-'236 describes that its multi-layered fluid flow control structure (sublayer 30) provides several benefits for these types of absorbent articles. Ponomarenko-'236 explains that sublayer 30 helps “acquire liquid (urine) and temporarily hold the liquid and allow it to pass, or transport it to the absorbent core underneath (in Z-direction), and optionally also distribute it in the X and Y direction of the sublayer” and “facilitates the absorption of the fluid by the absorbent core below.” EX1007-Ponomarenko-'236, 7:8-16; *see also, id.*, 6:47-49 (sublayer design “ensures an excellent feces storage and isolation and during the whole usage of the diaper, even when a user is moving or sitting on the diaper”).

243. A person of ordinary skill in the art would have therefore been motivated to modify Nakazawa-'190 by replacing its diffusion sheet with Ponomarenko-'236's sublayer to get the same benefits and advantages in the Nakazawa-'190 absorbent article. Using Ponomarenko-'236's sublayer would improve Nakazawa-'190's article by increasing fluid penetration rate, i.e., making the fluid acquisition time faster, while reducing fluid leakage of large fluid volumes from the absorbent article.

244. A person of ordinary skill in the art would have also found it obvious to make the combinations I propose above for a few additional reasons. First, the

proposed combinations involve the simple substitution of one known element (Ponomarenko-'236's sublayer) for another (Nakazawa-'190's diffusion sheet) to obtain predictable results (optimized fluid acquisition and distribution). Second, the proposed combinations involve use of a known technique (Ponomarenko-'236's sublayer) to improve a similar device (Nakazawa-'190's multi-layer absorbent article) in the same way (by improving fluid acquisition and distribution).

245. A person of ordinary skill in the art would have had a reasonable expectation of success at replacing Nakazawa-'190's diffusion sheet with Ponomarenko-'236's sublayer 30. Nakazawa-'190 and Ponomarenko-'236 each discuss similarly designed multi-layered absorbent articles that have acquisition layers to help with fluid acquisition. Ponomarenko-'236's sublayer 30 would have been applied to Nakazawa-'190 in the same way it is used in Ponomarenko-'236's absorbent article. Combining these elements would have = required no more than routine skill and involved the simple combination of known components to yield predictable results. Thus, this limitation and claim 1 would have been obvious in view of Nakazawa-'190 and Ponomarenko-'236.

246. Accordingly, because Nakazawa-'190 in combination with Ponomarenko-'236 discloses each of the elements or limitations of claim 1, and a person of ordinary skill in the art would have been motivated to combine the teachings of Nakazawa-'190 and Ponomarenko-'236 with a reasonable expectation

of success, it is my opinion that Nakazawa-'190 in view of Ponomarenko-'236 renders claim 1 obvious.

2. Claim 2: “The absorbent article of claim 1, wherein the first perforated polymeric layer has a basis weight of from 60 g/m² to 100 g/m².”

247. It is my opinion that Nakazawa-'190 in view of Ponomarenko-'236 discloses the additional limitation required by claim 2.

248. Nakazawa-'190 in view of Ponomarenko-'236 renders obvious that the first perforated polymeric layer (e.g., Nakazawa-'190 diffusion sheet 63; Ponomarenko-'236 additional acquisition layer) has a basis weight from 60 g/m² to 100 g/m².

249. Ponomarenko-'236 describes that sublayer 30 comprises at least one nonwoven acquisition layer and that it is “preferred that such materials have a high basis weight, i.e., of 40 gsm [g/m²] or more, preferably even 60 gsm [g/m²].” EX1007-Ponomarenko-'236, 10:4-17. Ponomarenko-'236 goes on to describe that holes can be formed through the different layers of sublayer 30, such that a person of ordinary skill in the art would have found it obvious that Ponomarenko-'236 discloses forming perforations in a layer with a basis weight of over 60 gsm. EX1007-Ponomarenko-'236, 10:31-41.

250. A person of ordinary skill in the art would have found it obvious to modify Nakazawa-'190 by replacing the diffusion sheet with Ponomarenko-'236's

sublayer and reasonably expected success for the same reasons that I explained above for limitation 1[h]. *See* Section X.B.1.i. Because Ponomarenko-'236 explains that a high basis weight was preferable for one of the layers of sublayer 30, a person of ordinary skill in the art would have been motivated to use the sublayer 30, where one of the layers has a high basis weight, in place of the diffusion sheet of Nakazawa-'190 to obtain the same advantages as disclosed in Ponomarenko-'236.

3. Claim 3: “The absorbent article of claim 1, wherein the first perforated polymeric layer is a nonwoven, a film or a film/nonwoven laminate”

251. It is my opinion that Nakazawa-'190 in view of Ponomarenko-'236 discloses the additional limitation required by claim 3.

252. Nakazawa-'190 in view of Ponomarenko-'236 discloses a first perforated polymeric layer (e.g., Nakazawa-'190 diffusion sheet 63; Ponomarenko-'236 acquisition layer 36 and/or additional acquisition layer) that is a nonwoven, a film or a film/nonwoven laminate.

253. As I explained above, Nakazawa-'190 describes the diffusion sheet “can be made of a nonwoven fabric or porous plastic film.” EX1008-Nakazawa-'190, [0062].

254. Ponomarenko-'236 also explains that “[i]t may also be preferred that the sublayer (30) comprises, in addition to the fibrous acquisition layer above, one or more layers of nonwoven acquisition layers, including carded bonded nonwoven

acquisition layers, such as carded resin-bonded nonwovens, embossed carded resin-bonded non-woven acquisition layers, and optionally highloft carded resin-bonded nonwoven acquisition layers, or preferably carded through-air-bounded nonwoven acquisition layers, carded thermo-bonded nonwoven acquisition layers; most preferably are non-embossed carded resin-bonded non-woven acquisition layers.”

EX1007-Ponomarenko-’236, 10:4-15. As explained above for Claim 2, it would have been obvious to a person of ordinary skill in the art that this layer in Ponomarenko-’236 would have been perforated in certain embodiments.

255. For the same reasons as stated above in limitation 1[h] and Claims 2, a person of ordinary skill in the art would have found it obvious to modify Nakazawa-’190 by replacing the diffusion sheet with Ponomarenko-’236’s sublayer and would have reasonably expected success.

4. Claim 4: “The absorbent article of claim 1, wherein the first perforated polymeric layer is a three-dimensionally formed layer having penetrating apertures extending from a first surface of the first perforated layer towards a second surface of the first perforated layer and forming protrusions on said second surface”

256. It is my opinion that Nakazawa-’190 in view of Ponomarenko-’236 discloses the additional limitation required by claim 4.

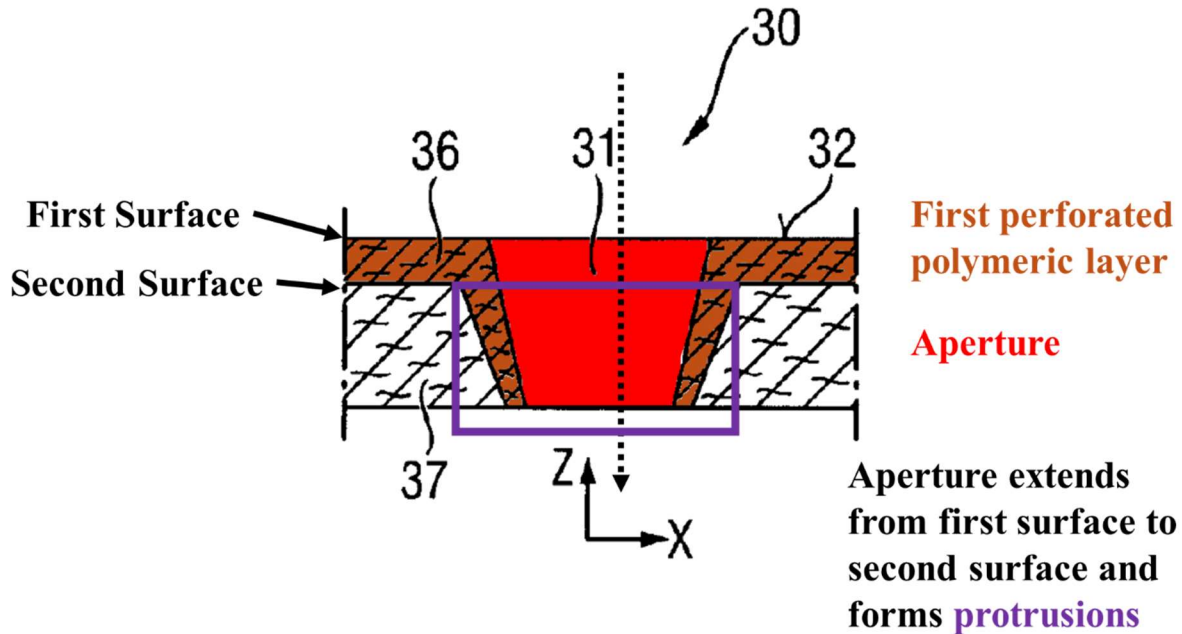
257. Nakazawa-’190 in view of Ponomarenko-’236 describes that the first perforated polymeric layer (e.g., Ponomarenko-’236 acquisition layer 36 of sublayer

30) is a three-dimensionally formed layer having penetrating apertures extending from a first surface of the first perforated polymeric layer towards a second surface of the first perforated polymeric layer and forming protrusions on said second surface.

258. First, I explained above in Section X.B.3 that Nakazawa-'190 discloses this limitation.

259. Second, Ponomarenko-'236 also describes that “[w]hen the sublayer (30) comprises two or more layers, it may be beneficial that the holes (31) are formed by pushing, e.g., by pushing a hole forming tool onto the surface of the first layer (36) and through the first and second layer (37) and further layers, such that part of the material of the first layer (36) is pushed into the holes (31).” EX1007-Ponomarenko-'236, 10:31-37; claim 1.

260. I have annotated Figure 5 in Ponomarenko-'236 to show the disclosed aperture with a first and second surface where the aperture protrudes onto the second surface.



EX1007-Ponomarenko-'236, Figure 5.

261. As I explained in limitation 1[h], the benefits of Ponomarenko-'236's sublayer described above would have motivated a person of ordinary skill in the art to modify Nakazawa-'190 by replacing the diffusion sheet with Ponomarenko-'236's sublayer to realize the same results in the Nakazawa-'190 absorbent article. It likewise would have been obvious and a person of ordinary skill in the art would have reasonably expected success to include a "first perforated polymeric layer that is a three-dimensionally formed layer having penetrating apertures extending from a first surface of the first perforated polymeric layer towards a second surface of the first perforated polymeric layer and forming protrusions on said second surface" because Ponomarenko-'236 explains that such

a configuration “may provide smooth edges and walls of the holes (31), and furthermore it may inhibit the fibres of the second layer (37) to migrate into the holes.” EX1007-Ponomarenko-’236, 10:37-41. For these reasons, a person of ordinary skill in the art would have been motivated to use Ponomarenko-’236 first perforated polymeric layer with apertures in place of the diffusion sheet of Nakazawa-’190 to obtain the same advantages as disclosed in Ponomarenko-’236.

262. For the same reasons as stated above in limitation 1[h] and Claims 2-3, a person of ordinary skill in the art would have found it obvious to modify Nakazawa-’190 by replacing the diffusion sheet with Ponomarenko-’236’s sublayer and would have reasonably expected success.

5. Claim 5: “The absorbent article according to claim 4, wherein the first perforated polymeric layer is arranged with said second surface facing the non-perforated fibrous polymeric layer.”

263. It is my opinion that Nakazawa-’190 in view of Ponomarenko-’236 discloses the additional limitation required by claim 5.

264. Nakazawa-’190 in view of Ponomarenko-’236 describes that the first perforated polymeric layer (e.g., Ponomarenko-’236 acquisition layer 36 of sublayer 30) is arranged with said second surface facing the non-perforated polymeric layer (Ponomarenko-’236 acquisition layer 37 and/or other acquisition layer).

265. As I explained above, Ponomarenko-'236 describes that “[t]he sublayer (30) may be made by forming holes (31) in a continuous sublayer (30) (i.e., without holes (31)), for example by punching or pushing holes (31) in a said sublayer (30).” EX1007-Ponomarenko-'236, 10:24-30. Ponomarenko-'236 explains that “[w]hen the sublayer (30) comprises two or more layers, it may be beneficial that the holes (31) are formed by pushing, e.g., by pushing a hole forming tool onto the surface of the first layer (36) and through the first and second layer (37) and further layers, such that part of the material of the first layer (36) is pushed into the holes (31).” *Id.*, 10:31-37.

266. For the same reasons as I stated above with respect to limitation 1[h] and Claims 2-4, a person of ordinary skill in the art would have found it obvious to modify Nakazawa-'190 by replacing the diffusion sheet with Ponomarenko-'236's sublayer and would have reasonably expected success.

6. Claim 7: “The absorbent article according to claim 4, wherein the average size of the apertures in the first perforated polymeric layer is 0.5-5 mm”

267. It is my opinion that Nakazawa-'190 in view of Ponomarenko-'236 discloses the additional limitation required by claim 7.

268. Ponomarenko-'236 describes that the average size of the apertures in the first perforated polymeric layer has a size range that overlaps with the claimed range of 0.5-5 mm. For example, Ponomarenko-'236 states that the “sublayer has

holes that have a circular circumference with an average smallest dimension of from 4 mm to 10 mm, said holes being disposed in the topsheet-facing surface of the sublayer.” EX1007-Ponomarenko-’236, claim 5; *see also id.*, 7:48-53 (“The holes (31) of the sublayer (30) have an average smallest dimension of 3 to 10 mm, preferably from 4 mm to 10 mm, or more preferably from 4mm to 8 mm”). I have been informed and understand that when the prior art discloses a range that overlaps with a claimed range, then the prior art provides a prima facie basis for the claimed range being obvious.

269. Further, as I explained above, the claimed range of aperture sizes was well-known. *See* EX1016-Cohen-’429, [0014] (describing an acquisition/distribution layer that has an “average pore size of 0.3-10, preferably 0.5-5.0...mm in diameter”). Therefore, a person of ordinary skill in the art would have found this aperture size obvious.

270. For the same reasons that I explain in section X.D.1.a above, a person of ordinary skill in the art would have been motivated to combine the teachings of Nakazawa-’190 with Ponomarenko-’236 to achieve the claimed invention of claim 7.

7. Claim 8: “The absorbent article according to claim 1, wherein open areas of the first perforated polymeric layer comprise 5-30% of the first perforated polymeric layers”

271. It is my opinion that Nakazawa-'190 in view of Ponomarenko-'236 discloses the additional limitation required by claim 8. I note that in my review of the '138 patent I did not find anything in the disclosure that explained why this precise range in open area percentage was critical to the invention or the functionality of the absorbent article.

272. Ponomarenko-'236 describes “[t]he sublayer (30) herein has a region (33) with through or blind holes (31) that has an open area of from 15% to 50% of the total surface area of said region (33), (whereby the open area is the sum of the surface area of the holes (31) as measured in the cross section of the holes in or on the surface (32) of the sublayer (30) that faces the topsheet (20)).” EX1007-Ponomarenko-'236, 8:1-6. *See also id.*, claim 2 (“The absorbent article of claim 1, whereby said overlap area is from 25% to 40% of the surface area of said overlap zone”).

273. For the same reasons that I explain in section X.D above with respect to claim 1[h], and claims 2-5 and 7, a person of ordinary skill in the art would have been motivated to combine the teachings of Nakazawa-'190 with Ponomarenko-'236 to achieve the claimed invention of claim 8 and would have had a reasonable expectation of doing so.

E. Ground V: Claims 1, 3-5, 21-22, and 24-25 Are Anticipated By Nakazawa-'190

274. As explained above, Nakazawa-'190 discloses limitations 1[a]-[g] and [i]-[j], 3-5, 21-22, and 24-25 for the same reasons I identify in Ground II and incorporate by reference here. *See* Section X.B.

275. I have also reviewed the Appendix that Patent Owner attached to its Complaint in the parallel district court litigation. EX1014-Complaint at Appendix A. In this Appendix, Patent Owner has identified the core wrap that is wrapped around the lower absorbent core in the accused product as being the alleged non-perforated fibrous polymeric layer of the claimed “fluid flow control structure.”

276. In my experience, core wrap is a well-known component in absorbent articles that is “designed to contain the storage layer and provide structural integrity when the storage layer is wet or dry.” EX1015-US7923597, 1:35-37. It, however, is not considered part of an acquisition / distribution layer, nor does it help “provide[] the article with high intake capacity” as the '138 patent states the fluid flow control structure does. EX1001-USP138, 2:21-22. Instead, core wraps are used to help keep absorbent cores together and manage the SAP during manufacturing. EX1018-White2000, 44.15-44.16 (Explaining that the core wrap or tissue wrap prevents “migration” of the absorbent materials that make up the absorbent layer (e.g., the super absorbent polymer (SAP) and wood pulp fluff).).

277. To the extent that Patent Owner contends the core wrap around the lower absorbent core in the accused product is part of the fluid flow control structure, Nakazawa-'190 also has a non-perforated fibrous polymeric layer as a part of its fluid flow control structure. It is therefore my opinion that Nakazawa-'190 anticipates Claims 1, 3-5, 21-22, and 24-25 of the '138 patent in view of Patent Owner's position on the scope of the claims.

1. Claim 1[h]: “said fluid control structure being a layered structure comprising a non-perforated fibrous polymeric layer and a first perforated polymeric layer”

278. It is my opinion that, based on Patent Owner's position on the scope of this limitation, Nakazawa-'190 discloses a fluid control structure being a layered structure comprising a non-perforated fibrous polymeric layer (e.g., hydrophilic sheet) and a first perforated polymeric layer (e.g., diffusion sheet 63).

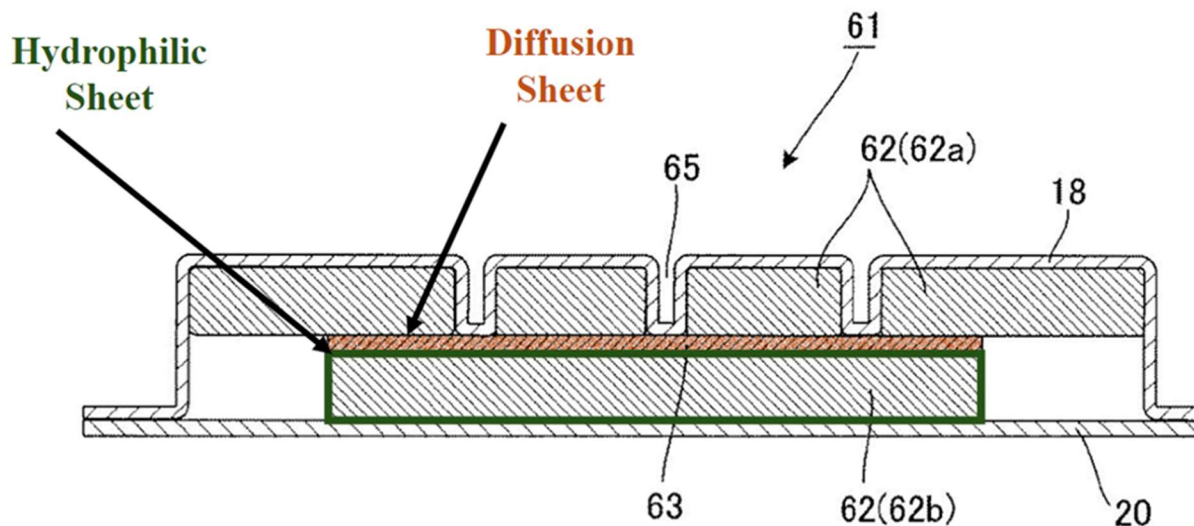
279. For example, as I explained above in Grounds II and IV, Section X.B and X.D, Nakazawa-'190 discloses a single layer diffusion sheet 63 that can be made of a porous plastic film.

280. Furthermore, Nakazawa-'190 describes, “[w]hile not shown in the figures, the absorbent material is generally wrapped on the back surface and side surfaces with a hydrophilic sheet serving as a carrier to prevent leakage of superabsorbent polymer and to prevent deformation of the absorbent material on the production line.” EX1008-Nakazawa-'190, [0082]. Nakazawa-'190 describes that

either the first absorbent material 62a or the lower absorbent material 62b can be wrapped in the hydrophilic sheet. *Id.* A person of ordinary skill in the art would have understood that this hydrophilic sheet is a core wrap.

281. I have annotated Figure 14A to show how the hydrophilic sheet wraps the lower absorbent material in some embodiments. *Id.*, [0084].

[Fig. 14A]



EX1008-Nakazawa-'190, Figure 14A.

282. If the hydrophilic sheet is considered the non-perforated fibrous layer of the fluid flow control structure, then every limitation in claim 1 is disclosed in the embodiment shown in Figures 11 and 14A of Nakazawa-'190 and it is therefore my opinion that Nakazawa-'190 anticipates claim 1.

2. Claim 3: “The absorbent article of claim 1, wherein the first perforated polymeric layer is a nonwoven, a film or a film/nonwoven laminate”

283. As I explained above and incorporate by reference here, Nakazawa-’190 discloses a first perforated polymeric layer (e.g., diffusion sheet 63) that is a nonwoven, a film or a film/nonwoven laminate.

284. For example, Nakazawa-’190 describes the diffusion sheet “can be made of a nonwoven fabric or porous plastic film.” EX1008-Nakazawa-’190, [0062].

285. Accordingly, assuming the hydrophilic sheet in Nakazawa-’190 is considered to be part of the fluid flow control structure, it is my opinion that Nakazawa-’190 anticipates claim 3.

3. Claim 4: “The absorbent article of claim 1, wherein the first perforated polymeric layer is a three-dimensionally formed layer having penetrating apertures extending from a first surface of the first perforated layer towards a second surface of the first perforated layer and forming protrusions on said second surface”

286. As I explained above, Nakazawa-’190 describes that the first perforated polymeric layer (e.g., Nakazawa-’190 diffusion sheet 63) is a three-dimensionally formed layer having penetrating apertures extending from a first surface of the first perforated polymeric layer towards a second surface of the first perforated polymeric layer and forming protrusions on said second surface.

287. For example, as I discuss in Section X.B.1.i, Nakazawa-'190 discloses "a porous plastic film" that may be used for the diffusion sheet (i.e., fluid flow control structure). EX1008-Nakazawa-'190, [0068]. Nakazawa-'190 describes that "the shape of the pores in the porous plastic film should be funnel-shaped, that is, the size of the opening in the pores decreases progressively from the front surface to the back surface of the porous plastic film." *Id.* Nakazawa-'190 explains that "[t]his configuration allows excretory fluid to pass through the pores of the porous plastic film and reduces liquid backflow." *Id.*

288. Accordingly assuming the hydrophilic sheet in Nakazawa-'190 is considered to be part of the fluid flow control structure, it is my opinion that Nakazawa-'190 anticipates claim 4.

4. Claim 5: "The absorbent article according to claim 4, wherein the first perforated polymeric layer is arranged with said second surface facing the non-perforated fibrous polymeric layer"

289. It is my opinion that Nakazawa-'190 discloses the additional limitation required by claim 5.

290. For example, Nakazawa-'190 describes a first perforated polymeric layer (e.g., Nakazawa-'190 diffusion sheet 63) is arranged with said second surface facing the non-perforated polymeric layer (e.g., Nakazawa-'190 diffusion sheet 63).

291. For example, as I discuss in Section X.B.1.i, Nakazawa-'190 describes that diffusion sheet 63 can have "funnel-shaped" pores that go from the front surface (the surface facing the user) to the back surface (the surface facing the backsheet) of the "porous plastic film." EX1008-Nakazawa-'190, [0068]. *See also id.*, Abstract (describing an absorbent article comprising a diffusion sheet 23 with higher permeability than the absorbent material 22), claim 1 ("[a]n absorbent article comprising an absorbent material [and] a diffusion sheet with higher liquid permeability than the absorbent material"), [0013] (same). Thus, the "second surface" of the diffusion sheet 63 of Nakazawa-'190 into which the funnel-shaped pores protrude faces the non-perforated fibrous polymeric layer (e.g., the hydrophilic sheet), which is wrapped around the second absorbent layer.

292. Accordingly, assuming the hydrophilic sheet in Nakazawa-'190 is considered to be part of the fluid flow control structure, it is my opinion that Nakazawa-'190 anticipates claim 5.

XI. AVAILABILITY FOR CROSS-EXAMINATION

293. In signing this declaration, I recognize that the declaration will be filed as evidence in a contested case before the Patent Trial and Appeal Board of the United States Patent and Trademark Office. If cross examination is required of me, I will appear for cross examination during the allotted time.

XII. RIGHT TO SUPPLEMENT

294. I reserve the right to supplement my opinions in the future to respond to any arguments that Patentee raises and to take into account new information as it becomes available to me.

XIII. JURAT

295. I declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

Dated: October 25, 2024



Dr. Behnam Pourdeyhimi

APPENDIX A

Curriculum Vitae for Behnam Pourdeyhimi

William A. Klopman Distinguished Professor of Textile Materials
Professor, Textile Engineering, TECS, College of Textiles
Affiliated Professor, Biomedical Engineering, NC STATE College of Engineering & UNC Chapel Hill
Associate Dean for Industry, Research, and Extension, The Wilson College of Textiles
Executive Director, The Nonwovens Institute
North Carolina State University
1010 Main Campus Drive
Raleigh, NC 27606
Office: 919-515-1822
Mobile: 919-810-6015
Fax: 919-515-4556
Email: bpourdey@ncsu.edu

EDUCATION

Year	Degree & Field of Study
1982	Ph.D., The University of Leeds, UK

EMPLOYMENT

Period	Position
2007-Present	Professor, Textile Engineering, Chemistry and Science, Wilson College of Textiles, NC State.
2007-Present	Executive Director, The Nonwovens Institute, NC State.
2004-Present	Affiliated Professor, Biomedical Engineering, NC STATE College of Engineering & UNC Chapel Hill.
2007-2012	Affiliated Professor, Chemical and Bio-molecular Engineering, College of Engineering, NC State.
2004-Present	Associate Dean for Industry Research and Extension, College of Textiles, NC State.
2004-Present	William A. Klopman Distinguished Professor of Textile Materials, NC State.
2000-2013	Director, The Nonwovens Cooperative Research Center, NC State.
1999-2000	Co-Director, The Nonwovens Cooperative Research Center, NC State.
1999-2007	Professor, Textiles and Apparel, Technology and Management, College of Textiles, NC State.
1995-1999	Professor, School of Textile and Fiber Engineering, Georgia Tech.
1992-1995	Associate Professor, Materials and Nuclear Engineering, University of Maryland at College Park.
1992-1994	Program Director, Textiles and Consumer Economics, University of Maryland at College Park.
1989-1992	Associate Professor, Textiles and Consumer Economics, University of Maryland at College Park.
1984-1988	Assistant Professor, Textiles and Consumer Economics, University of Maryland at College Park.
1983-1984	Research Associate, Department of Design and Environmental Analysis, Cornell University.
1982-1983	Research Associate, Department of Textile Materials and Management, NC State.
1980-1982	Lecturer of Mathematics, Airedale and Wharfedale College of Further Education, Leeds, UK.

Most Recent Honors and Awards

Year	Award Title
2020	Fellow of the National Academy of Inventors
2018	The Holladay Medal for Excellence; The highest faculty award bestowed by NC State University.
2015	The O'Max Gardner Award by the UNC System; Highest award by the UNC system
2014	TAPPI Leadership Award
2010	Outstanding Extension Service Award, NC State
2010	Induction into the Academy of Outstanding Faculty Engaged in Extension and Engagement
2010	Centenary Award of the Textile Institute by the Governing Council of the Textile Institute.
2009	INDA Lifetime Technical Achievement Award
2008	TAPPI Nonwovens Division 2008 Technical Award and Mark Hollingsworth Prize
2004	ASTM D-13 Dewitt Smith Medal
2004	William A. Klopman Distinguished Endowed Chaired Professor, NC State
1996	Elected as President of The Fiber Society for 1996-1997
1995	Elected as Vice President of The Fiber Society
1994	F.T.I. (Fellowship of the Textile Institute)
1994	Recipient of The Fiber Society Distinguished Scientist Award
1994	Distinguished Honors Teacher, University of Maryland
1993	Distinguished Honors Teacher, University of Maryland
1992	Fiber Society Lecturer for 1992-1993
1992	Selected as an Outstanding Teacher, University of Maryland

SUMMARY OF TRAINING ACHIEVEMENTS

RESEARCH ASSOCIATES	Number
Research Associates Advised	21
Ph.D. Students Chaired/Co-chaired	64
M.S. Students Chaired/Co-chaired	39

RESEARCH ASSOCIATES/VISITING SCHOLARS

Period	Name	Present Position/Status
2014-2020	Joiode, A.	Research Associate, NWI, NC State
2014-2016	Tian, T.	Wellman Advanced Materials
2013-2015	Shahreen, L.	Mann & Hummel
2013-2016	Ievtushenko, O.	Eastman Chemical
2012-2016	Khansari, S.	Pepsi Co.
2011-2016	Rangasamy, L.	
2006-2009	Yoem, B.	3M
2006-2008	Anantharamaiah, N.	Hollingsworth & Vose
2003-2007	Verenich, S.	Consultant
2003-2007	Mazé, B.	Dir of Simulation, NWI
2002-2005	Zamfir, M.	Professor, Romania
2001-2007	Tafreshi, H.	Professor, Mechanical Engineering, VCU
2000-2008	E. Shim,	Professor, NC State
2000-2001	Kohel, L.	Professor, ENSAIT, France
1999-2002	Kim, H. S.	Professor, Pusan National University, Korea
1995-1997	Tanaka, S.	Director of Nonwovens Technologies, Toyobo, Japan
1994-1995	Jerbi, A.	Canadian Government
1992-1993	Xu, B.	Professor, and Department Head, UT Austin
1992-1993	Wu, Y.	Honeywell
1990-1992	Ulçay, Y.	President, Bursa University, Turkey
1986-1987	Ding, S.	Professor, China

COMPLETED DOCTORAL RESEARCH DIRECTED/CO-DIRECTED

Period	Name	Present Position/Status
2023-date	Morgan Gilbert	Current PhD Student
2023-date	Nur Udding	Current PhD Student
2023-date	Mahsa Nazem	Current PhD Student
2021 - date	Nishant Bhatta	Current PhD Student
2021 - date	Mashfiqur Rahman	Current PhD Student
2021 - date	Shajid Rahman	Current PhD Student
2021 - date	Busra Ozdemir	Current PhD Student
2019 - date	Christian Lee	Current PhD Student
2019-2023	Sophie Nunno-Gorbachev	Consultant
2017-2020	Gharde, Avoni	Applications Engineer, Natural Fiber Welding, Inc.
2017-2020	Roberts, Erin	Research Scientist, Mann and Hummel
2013-2016	Fakhimi, Sameneh	Research Scientist, American Air Filtration
2013-2016	Amid, Hooman	Research Scientist, Saint-Gobain
2013-2016	Kiyak, Yasar	R&D Engineer, SWM International
2011-2017	Tuin, Stephen	Post-doctoral Associate
2013-2016	Luzius, Dennis	Research Scientist, Groz-Beckert
2013-2016	Mohseni, Sameneh	Research Scientist, Kimberly Clark
2013-2016	Gholipour, Mehdi	Research Scientist, Kimberly Clark
2013-2016	Leary, Jennifer	Research Engineer, Hollingsworth & Vose
2013-2016	Maier, Paul	Research Scientist, adidas
2012-2015	Wei, Wei	Research Scientist, KingFa
2011-2015	Bateny, Fatemeh	Tech Transfer, NC State
2010-2014	Sun, Ning	Research Scientist, Xerium
2009-2013	Amirnasr, Elham	Research Scientist, Mann and Hummel
2009-2013	Stoughton, Hanna	Research Scientist, 3M
2009-2012	Ievtushenko, Olga	Research Scientist, Eastman Chemical
2008-2012	Higham, Ana	Research Scientists, Thermal Instruments
2008-2012	Kilic, Ali	Assistant Professor, Istanbul Technical University
2008-2012	Hassan, Mohammed	Research Scientist, Eastman Chemical
2008-2012	Hollowell, Kendall	Research Scientist, Freudenberg Nonwovens
2008-2011	Canbolat, Mehmet Fatih	Assistant Professor, Izmir, Turkey
2008-2011	Honarbaksh, Sara	Research Scientist, KCC
2008-2011	Dasdemir, Mehmet	Assistant Professor, Gaziantep, Turkey
2008-2011	Aykut, Yakup	Assistant Professor, Bursa Technical University, Turkey
2008-2011	Suragani Venu, Logo	Research Scientists, Ahlstrom
2008-2010	Tyagi, Sheria	Consultant, India
2007-2011	Bagherzade, Arash	Research Scientist, H&V
2007-2011	Rangasamy, Logonathan	Research Associate, The Nonwovens Institute
2007-2010	Jung, K.	Research Associate, University of Texas
2006-2011	Chu, Ann	Consultant
2005-2009	Haslauer, Carla	Research Associate, BME, NC State
2005-2008	Talwar, Sachin	Research Scientist, 3M
2005-2008	Jaganathan, Sudhakar	Research Scientist, H&V
2005-2008	Paul, Shria	Research Scientist, Intel
2004-2008	Qashou, Imad	Research Scientist, DuPont
2004-2008	Beginner, Asli	R&D Manager, Hanes Branded Apparel
2004-2007	Dalta, Vasantha	Research Scientist, Pall Corp.

2004-2007	Ichhaporia, Pratick	Tech Service Dir., Intertek
2004-2006	Karaguzel, Bucak	Associate Professor, Istanbul Technical University
2003-2008	Zapletalova, Tereza	Research Scientist, Freudenberg Advanced Materials
2003-2007	Wang, Qici	Research Scientist, DuPont
2003-2006	Fedorova, Natalya	Division Manage, 3M
2003-2006	Anantharamaiah, Nagandra	Research Scientist, H&V
2002-2005	Stewart, Melissa	Director of Innovation, Lycra.
2001-2004	Dani. Nikhil	Research Fellow, Clorox
1999-2001	Shim. Eunkyong	Professor, NC State
1990-1994	Ramanathan, Ravi	Senior Research Engineer, CSC
1989-1994	Na, Youngjo	Professor, University of Seoul, Korea
1989-1992	Xu, Bugao	Professor & Department Head, University of Texas at Austin
1988-1992	Presley, Ann Beth	Professor, University of Auburn
1987-1990	Wu, Yeja	Research Scientist, Honeywell
1986-1993	Gerde, Janice	Senior Engineer, US Customs
1986-1991	Wehrle, Louise	Research Associate, Wolcof and Associates
1985-1989	Ulca, Yusuf	President, Bursa University, Turkey

COMPLETED MASTERS RESEARCH DIRECTED/CO-DIRECTED

Period	Name	Present Position/Status
2020-2023	Morgan Gilbert	PhD Student
2016-2018	Alejandra C Garcia	Fibertex, Quality Manager
2014-2016	Phalak, Sumit	Research Scientist, Lydall Filtration
2014-2016	Hall, Michael	Research Scientist, Krypton
2012-2014	Schenk, Annette	Research Scientist, Mann and Hummel
2013-2015	Strader, Philip	Research Engineer, Analytical Facilities, NC State
2013-2015	Halligan, William	Research Engineer, Nike
2013-2015	Moore, Dan	Research Engineer, NuTex Concepts
2015-2017	Tabor, Jordan	PhD Student, NC State
2006-2007	Canon, C.	PhD Student, NC State
2004-2008	Suwanamek, I.	Ministry of Technology, Thailand
2004-2006	Chhapparwal, S.	Research Engineer, Politec
2003-2006	Kennerly, P.	Research Engineer, Milliken
2003-2006	Williams, S.	Research Engineer, Milliken
2003-2005	Jayaraman, K. A.	Research Engineer, Spuntech
2003-2005	Arumugam, K.	Research Engineer, Hof Textiles
2003-2005	Erkman, E.	Self-Employed
2003-2005	Hatiboglu, Bilge	Professor, Istanbul Technical University
2003-2004	Vyas, K.	Consultant
2002-2004	Zaveri, Mitul	Research Engineer, Saint-Gobain
2001-2003	Filiz, Selcuk	Research Engineer, Freudenberg
2001-2003	Erickson, Jodi	Research Engineer, Freudenberg
2000-2002	Vaydia, Neha	Research Engineer, Raytech Composites
2000-2002	Grissett, Greg	Patent Attorney, Partner
2000-2002	Begenir, Asli	Research Scientist, Hanesbrands
1999-2001	Konopka, Amy	Consultant
1996-1999	Velu, Yogi	Research Scientist, DuPont
1996-1999	Niroomand, Ali	Research Chemist, Ethicon
1996-1997	Wang, X.	Research Engineer, Nordson Fiber Systems

1994-1995	Lee, Fred	Materials Engineer, Atlas Materials Group
1990-1992	Munter, Catherine	Consultant
1989-1991	Dharmadhikary, Rahul	Senior Research Scientist, Clarcor
1989-1991	Agarwal, Vishvarob	Senior Engineer, Johnson and Johnson
1989-1991	Chiu, Jessica	Senior Engineer, Eli Lili
1989-1990	Xu, Bugao	Professor and Dept. Head, University of Texas at Austin
1985-1988	Moreland, Janet	Senior Engineer, Bard
1985-1988	Merrit, Jane	Consultant
1984-1986	Feldstein, Marsha	Senior Engineer, Honeywell

SUMMARY OF SCHOLARY ACTIVITIES

ACTIVITY	Number
Books	3
Refereed Publications	380+
Presentations	200+
US Patents	27+
International Patents	50+

BOOKS

1. Yarin, A., Pourdeyhimi, B. and Ramakrishna, S. (2014). Fundamentals and Applications of Micro and Nanofibers, Cambridge Publishing, ISBN: 9781107060296 (2014).
2. Batra, S. K., and Pourdeyhimi, B. (2012). Introduction to Nonwovens, Destech Publishing, (2012).
3. Pourdeyhimi, B. (1999). *Imaging and image analysis for plastics*. Norwich, NY: Society of Plastics Engineers, Plastics Design Library.

CHAPTERS IN BOOKS

1. Kilic, A., Russell, S., Shim, E, and Pourdeyhimi, B. (2017). The charging and stability of electret filters, Fibrous Filter Media (editors: Philip J. Brown, Christopher L. Cox,), Woodhead Publishing.
2. Sinha-Ray, S., Zhang, Y., Yarin, A. L., Davis, S. C. and Pourdeyhimi, B. (2011). Solution Blowing of Soy Protein Fibers, Biobased Monomers, Polymers and Materials, 12, 2357-2363, (2011).
3. Pourdeyhimi, B. (2007). Characterization, testing and Modeling of Nonwovens, Handbook of Nonwovens, S. J. Russell (Ed.), CRC Press, (2007), ISBN-13: 9781855736030.
4. Pourdeyhimi, B. (2007). Textiles Nanotechnology, Handbook of Nanoscience, Engineering, and Technology, Second Edition, William A. Goddard III, Donald W. Brenner, Sergey E. Lyshevski, Gerald J. Iafrate (Eds.), CRC Press, (2007), ISBN: 9780849375637.
5. Pourdeyhimi, B., and Batra, S. K., ITMA '99: A Review, Textile Progress, No. 1/2, (30), 51-68, (2000).
6. Pourdeyhimi, B, Ulcay, Y., Ramanathan, R., and Sobus, J. (1993), Measuring Heat of Polymerization in Acrylic Bone Cements Using Infra-red Thermographs., Proceedings of the 16th Annual Energy-Sources Technology Conference and Exhibition Houston, Texas., 259-262, 53 (1993).
7. Pourdeyhimi, B., & Ulcay, Y. (1992)., Characterization of Mechanical Properties in Vascular Prostheses: Dilation, Design Analysis, Machinability, and Characterization of Composite Materials, (ed. F. Veniali, A. Ertas, A. Diilio and V. Tagliaferri), Vol 47-6, 107-115, (1992).
8. Pourdeyhimi, B., & Ulcay, Y. (1992). A study on bonding properties of Kevlar 149 fibers for use in PMMA Bone cements. In Proceedings of the 1992 Engineering Systems Design and Analysis Conference: presented at the First European Joint Conference on Engineering Systems Design and Analysis, Istanbul, Turkey, June 29-July 3, 1992. (pp. 143-149). New York: American Society of Mechanical Engineers.

9. Pourdeyhimi, B., & Ulcay, Y. (1992). Statistical Analysis of Tensile Strength of Kevlar 149 Fibers, Design Analysis, Machinability, and Characterization of Composite Materials, (ed. F. Veniali, A. Ertas, A. Diilio and V. Tagliaferri), Vol 47-6, 149-155, (1992).
10. Pourdeyhimi, B., Ulcay, Y., & Agarwal, V. (1991). The effect of chemical etching on fracture toughness of 3D randomly distributed spectra 900 and spectra 1000 discontinuous fiber reinforced composites. In D. Hui, & T.J. Kozik (Eds.), Composite material technology, 1991: presented at the Fourteenth Annual Energy-Sources Technology Conference and Exhibition, Houston, Texas, January 20-23, 1991. (pp. 41-51). New York, N.Y.: American Society of Mechanical Engineers.
11. Pourdeyhimi, B., Ulcay, Y., & Agarwal, V. (1991). Elastic properties of 3D randomly distributed Spectra 900 and Kevlar 49 discontinuous fiber reinforced composites. In D. Hui, & T.J. Kozik (Eds.), Composite material technology, 1991: presented at the Fourteenth Annual Energy-Sources Technology Conference and Exhibition, Houston, Texas, January 20-23, 1991. (pp. 51-59). New York, N.Y.: American Society of Mechanical Engineers.
12. Pourdeyhimi, B., Ulcay, Y., & Block, I. (1990). Improving the bond strength of Spectra 900 and Spectra 1000 high strength polyethylene fibers by chemical etching. In D. Hui, & T.J. Kozik (Eds.), Composite material technology, 1990: presented at the Thirteenth Annual Energy-Sources Technology Conference and Exhibition, New Orleans, Louisiana, January 14-18, 1990. (pp. 23-27). New York, N.Y.: American Society of Mechanical Engineers.
13. Pourdeyhimi, B., Ulcay, Y., & Wagner, H.D. (1990). Elastic properties of acrylic bone cements reinforced with ultra-high strength polyethylene fibers: The effect of bond strength. In D. Hui, & T.J. Kozik (Eds.), Composite material technology, 1990: presented at the Thirteenth Annual Energy-Sources Technology Conference and Exhibition, New Orleans, Louisiana, January 14-18, 1990. (pp. 131-137). New York, N.Y.: American Society of Mechanical Engineers.
14. Pourdeyhimi, B. and J. Moreland, A New In Vitro Fatigue Tester for Dynamic Testing of Vascular Prostheses, Elastic-Plastic Failure Modeling of Structures With Applications, (ed. D. Hui and T. J. Kozik), No. 141, 157-163, (1988).
15. Pourdeyhimi, B., Ulcay, Y., Singer, M., & Block, I. (1988). Mechanical characteristics of Spectra 900 and Spectra 1000 high strength polyethylene fibers. In D. Hu, & T. J. Kozik (Eds.), Advances in macro-mechanics of composite material vessels and components: Papers. New York: ASME.
16. B Pourdeyhimi, B. (1987). Vascular Grafts: Textile Structures and Their Performance, Textile Progress, No. 15, (3), 1-35, (1987).
17. Pourdeyhimi, B., & Wagner, H.D. (1987). Composite materials for use in orthopedic applications: Fracture behavior of acrylic bone cement reinforced with high toughness organic fibers. In I. H. Marshall (Ed.), Damage assessment and material evaluation. London: Elsevier Applied Science.

JOURNAL ARTICLES

19. S. Gautam, A. Kumar, H. Tafreshi & B. Pourdeyhimi, A simple approach to simulate corona-charged electret filters, Journal of Aerosol Science, 176, 106293, (2024).
<https://doi.org/10.1016/j.jaerosci.2023.106293>
20. S. Gautam, A. Kumar, H. Tafreshi & B. Pourdeyhimi, Designing Multi-Layer electret filters via numerical simulation, Chemical Engineering Science 286, 119680, (2024).
<https://doi.org/10.1016/j.ces.2023.119680>
21. Wu, J., Pourdeyhimi, B., & Yarin, A. L., Adaptable intelligent filters based on nanotextured nonwoven membranes containing water-insoluble hydrogels. JOURNAL OF APPLIED PHYSICS, 135(8).
<https://doi.org/10.1063/5.0173365> (2024).
22. N. Bhatta, H.V. Tafreshi, B. Pourdeyhimi, Toward formulating coalescence filtration: Characterizing wetting saturation via centrifugal force, International Journal of Multiphase Flow, Volume 170, 104641, (2024). <https://doi.org/10.1016/j.ijmultiphaseflow.2023.104641>
23. S. Atri, A. Kumar, S. Gautam, H. Tafreshi & B. Pourdeyhimi, Microscale modelling of electret filters using disordered 2-D domains, Powder Technology 431, 119094, (2024).
<https://doi.org/10.1016/j.powtec.2023.119094>

24. S. M. Rahman, S. Gautam, H. Tafreshi & B. Pourdeyhimi The role of 3D electrostatic field in modeling the electrospinning process, *Journal of Applied Physics*, 135, 014701, (2024).
<https://doi.org/10.1063/5.0187859>
25. Lemieux, P., Touati, A., Sawyer, J., Aslett, D., Serre, S., Pourdeyhimi, B., ... Monge, M., Use of semi-permeable bag materials to facilitate on-site treatment of biological agent-contaminated waste. *WASTE MANAGEMENT*, 178, 292–300. <https://doi.org/10.1016/j.wasman.2024.02.006>, (2024).
26. J. Lavoie, J. Fan, B. Pourdeyhimi, C. Boi, R. G. Carbonell, Advances in high-throughput, high-capacity nonwoven membranes for chromatography in downstream processing: A review, *Biotechnol Bioeng.* 2023;1–18, (2023). <https://doi.org/10.1002/bit.28457>
27. Y. Hewavidana, M. N. Balci, A. Gleadall, B. Pourdeyhimi, V. V. Silberschmidt, and E. Demirci, Assessing Crimp of Fibres in Random Networks with 3D Imaging, *Polymers*, 15, 1050, (2023)
<https://doi.org/10.3390/polym15041050>.
28. M. Jamali, Atri, Gautam, A. Saleh, H. V. Tafreshi & B. Pourdeyhimi, Macroscale modeling of electrostatically charged facemasks, *Aerosol Science and Technology*, Volume 57, Issue 7, (2023).
29. Hewavidana, Y., Balci, M., Gleadall, A., Pourdeyhimi, B., Silberschmidt, V., & Demirci, E., Algorithm to determine local basis weight of random fibrous networks with X-ray microtomography and SEM images. *TEXTILE RESEARCH JOURNAL*, Vol. 12., <https://doi.org/10.1177/00405175231214491>, (2023).
30. S. Gautam, A.M. Saleh, H.V. Tafreshi, J.G. Radney, B. Pourdeyhimi, Macroscale simulation of particle loading in electrostatically charged filters, *Journal of Aerosol Scienc*, Volume 173, 106212, (2023)
31. V. K. Balakrishnan, B. Pourdeyhimi, A. L. Yarin, Probability of jet roping in solution blowing of multiple jets, *J Appl Polym Sci.* 140: e54086, (2023).
32. Z. Machikiti, B. Pourdeyhimi, J. Genzer, and K. Efimenko, Tuning Interfacial Adhesion in Polyester/Polyamide Systems, *Ind. Eng. Chem. Res.* 62, 31, 12209–12219, (2023).
33. Y. J. Dias, V. D. Silva, B. Pourdeyhimi, E. S. Medeiros, and A. L. Yarin, Freestanding Carbon Nanofibers Derived from Biopolymer (Kraft Lignin) as Ultra-Microporous Electrodes for Supercapacitors, *Batteries* 2023, 9, 566, (2023). <https://doi.org/10.3390/batteries9120566>
34. Y. Hewavidana, M. Balci, A. Gleadall, B. Pourdeyhimi, V. V. Silberschmidt & E. Demirci, Algorithm to determine orientation distribution function from microscopic images of fibrous networks: Validation with X-ray microtomography, *Micron*. Volume 160, 103321, (2022).
35. Z. Machikiti, B. Pourdeyhimi, J. Genzer & K. Efimenko, Controlling PA6/PET adhesion to facilitate interfacial fracture, *European Polymer Journal*, Volume 171, 111196, (2022).
36. V. Balakrishnan, B. Pourdeyhimi & A. Yarin, Effect of inter-needle distance on jet roping and laydown structure in solution blowing, *J. Appl. Phys.* 132, 184903 (2022)
37. K. Schuchard, A. Pawar, B. Anderson, B. Pourdeyhimi & R. Shirwaiker, Multiphase CFD Modeling and Experimental Validation of Polymer and Attenuating Air Jet Interactions in Nonwoven Annular Melt Blowing, *Ind. Eng. Chem. Res.* 61, 37, 13962–13971, (2022).
38. Rahman, S. M., Tafreshi, H. V., & Pourdeyhimi, B., Physics-based deep neural network model to guide electrospinning polyurethane fibers, *Journal of Applied Polymer Science*, Vol. 9. (2022).
39. E. Roberts, S. Ghosh, and B. Pourdeyhimi, Process–Structure–Property relationship of roping in meltblown nonwovens, *The Journal of the Textile Institute*, (2021)
<https://doi.org/10.1080/00405000.2022.2029277>
40. S. Luiso, M. Petrecca, A. Williams, J. Christopher, O. Velev, B. Pourdeyhimi, P. Fedkiw, Structure-Performance Relationships of Li-Ion Battery Fiber-Based Separators, *ACS Applied Polymer Materials*, 4(5), 3676–3686, (2022)
41. Wei, W., Shim, E., Song, Y., & Pourdeyhimi, B., Synthesizing heat transfer factors on thermal bonding structure of mineral added polypropylene spunbond, *Journal Of Applied Polymer Science*, Vol. 1, (2022).
42. K. Jackson & B. Pourdeyhimi, Technological Innovation and Industrial Decline: The Case of the Automatic Loom in the British Cotton Industry, *Industrial Archaeology Review*, 44(1), 48–60. (2022).

43. Kim, E., Nelson, D. A., & Pourdeyhimi, B. (2021, June 6). The Role of Bonding Temperature on Fuzz Formation in Thermally Point-bonded Spunbond Nonwovens, *The Journal of the Textile Institute*, (2021).
44. Dias, Y., Sinha-Ray, S., Pourdeyhimi, B. & Yarin, A., Chicago Sky Blue diazo-dye release from poly(methyl methacrylate) (PMMA) electrospun nanofibers, *JOURNAL OF MOLECULAR LIQUIDS*, 1., Volume 345, 117771, (2021). [10.1016/j.molliq.2021.117771](https://doi.org/10.1016/j.molliq.2021.117771)
45. Cucumazzo, V., Demirci, E., Pourdeyhimi, B. & Silberschmidt, V., Anisotropic mechanical behaviour of calendered nonwoven fabrics: Strain-rate dependency, *JOURNAL OF COMPOSITE MATERIALS*, 55(13), 1783–1798, (2021).
46. Y. Dias, J. Robles, S. Sinha-Ray, J. Abiade, B. Pourdeyhimi, B. Niemczyk-Soczynska, D. Kolbuk, P. Sajkiewicz, A. Yarin, Solution-Blown Poly(hydroxybutyrate) and epsilon-Poly-L-lysine Submicro- and Microfiber-Based Sustainable Nonwovens with Antimicrobial Activity for Single-Use Applications, *ACS Biomaterials Science & Engineering*, 7(8), 3980–3992, (2021).
47. Kim, E., Nelson, D. A., & Pourdeyhimi, B. Development of a novel test method for the measurement of fuzz in nonwovens. *The Journal of the Textile Institute*, Vol. 6. (2021). <https://doi.org/10.1080/00405000.2021.1939517>
48. Chen, K., Zhang, W., Yarin, A. L., & Pourdeyhimi, B., Polymer melting temperatures and crystallinity at different pressure applied. *JOURNAL OF APPLIED POLYMER SCIENCE*. (2021). <https://doi.org/10.1002/app.50936>
49. S Ramesh, S., Davis, J., Roros, A., Eiben, J., Fabiani, T., Smith, R., ... Menegatti, S. (2021). Dual-Responsive Microgels for Structural Repair and Recovery of Nonwoven Membranes for Liquid Filtration. *ACS APPLIED POLYMER MATERIALS*, 3(3), 1508–1517. <https://doi.org/10.1021/acsapm.0c01360>
50. S. Luiso, J. Henry, B. Pourdeyhimi & P. Fedkiw, Meltblown Polyvinylidene Difluoride as a Li-Ion Battery Separator, *ACS Applied Polymer Materials*, 3(6), 3038–3048, (2021).
51. Y. Ma, N. Wisuthiphaet, H. Bolt, N. Nitin, Q. Zhao, D. Wang, B. Pourdeyhimi, P. Grondin, G. Sun, N-Halamine Polypropylene Nonwoven Fabrics with Rechargeable Antibacterial and Antiviral Functions for Medical Applications, *Acs Biomaterials Science & Engineering*, 7(6), 2329–2336.
52. Wei, W., Shim, E., Barnes, W., & Pourdeyhimi, B. (2021). Review of Structure-property relationship of melt spinning polypropylene fibers containing inorganic particulate CaCO₃ fillers. *TEXTILE RESEARCH JOURNAL*. <https://doi.org/10.1177/0040517520982001>
53. Shirwaiker, R. A., Fisher, M. B., Anderson, B., Schuchard, K. G., Warren, P. B., Maze, B., ... Pourdeyhimi, B. (2020). High-Throughput Manufacture of 3D Fiber Scaffolds for Regenerative Medicine. *TISSUE ENGINEERING PART C-METHODS*, 26(7), 364–374. <https://doi.org/10.1089/ten.tec.2020.0098>
54. A. L. Yarin, A. Sankaran, S. An, and B. Pourdeyhimi, “Constitutive modeling of polymers accounting for their hyperelasticity, plasticity, creep and viscoelastic relaxation,” *Polymer Testing*, vol. 85, p. 106444, May 2020, <https://doi.org/10.1016/j.polymertesting.2020.106444>
55. B. Peddinti, N. Morales-Gagnon, B. Pourdeyhimi, F. Scholle, R. Spontak, R. Ghiladi (2020) “Photodynamic Coatings on Polymer Microfibers for Pathogen Inactivation: Effects of Application Method and Composition”, *ACS Applied Materials & Interfaces*, *ACS Appl. Mater. Interfaces*. <https://dx.doi.org/10.1021/acsami.0c16953>.
56. Chen, K., Yarin, A. L., & Pourdeyhimi, B. (2020). Prediction of crystallinity of spunbond webs. *Journal of Applied Physics*, 128(20), 205101. <https://doi.org/10.1063/5.0029358>
57. B. Pourdeyhimi, (2020) “Surgical Mask Particle Filtration Efficiency (PFE): The Standard Needs to be Updated”, *Journal of Science and Medicine*, Vol 2, No.3, 2020. [10.37714/JOSAM.V2I4.50](https://doi.org/10.37714/JOSAM.V2I4.50)
58. Y. Dias, A. Kolbasov, S. Sinha-Ray, B. Pourdeyhimi, A. L. Yarin (2020), “Theoretical and Experimental Study of Dissolution mechanism of Cellulose”, *Journal of Molecular Liquids* 312 (2020) 113450,
59. G. Li, B. Pourdeyhimi, and A. L. Yarin, (2020) “Mutual Sliding Motion of Wrapped Filaments for Biomedical and Engineering Applications”, *Langmuir* 2020, 36, 4357–4369. [10.1021/acs.langmuir.0c00446](https://doi.org/10.1021/acs.langmuir.0c00446)

60. R. Dennis, B. Pourdeyhimi, A. Cashion, S. Emanuel, and D. Hubbard, (2020) "Durability of Disposable N95 Mask Material When Exposed to Improvised Ozone Gas Disinfection", *Journal of Science and Medicine*, Vol 2, No.1, 2020. [10.37714/JOSAM.V2I1.37](https://doi.org/10.37714/JOSAM.V2I1.37)
61. Heller, M., Li, Q., Esinhart, K., Pourdeyhimi, B., Boi, C., & Carbonell, R. G. (2020). Heat Induced Grafting of Poly(glycidyl methacrylate) on Polybutylene Terephthalate Nonwovens for Bioseparations. *Industrial & Engineering Chemistry Research*, 59(12), 5371–5380. <https://doi.org/10.1021/acs.iecr.9b04936>
62. A. L. Yarin, A. Sankaran, S. An, and B. Pourdeyhimi, "Constitutive Modeling of Polymers Accounting For Their Hyperelasticity, Plasticity, Creep And Viscoelastic Relaxation", *Polymer Testing* 85 (2020), <https://doi.org/10.1016/j.polymertesting.2020.106444>
63. A. Ghosal, K. Chen, S. Sinha-Ray, A. Yarin, and B. Pourdeyhimi, (2020) "Modeling Polymer Crystallization Kinetics in the Meltblowing Process", *Ind. Eng. Chem. Res.* (2020), 59, 399–412 DOI: 10.1021/acs.iecr.9b04840
64. K. Chen, A. Ghosal, A. Yarin, and B. Pourdeyhimi, "Modeling of Spunbond Formation Process of Polymer Nonwovens", (2020), *Polymer*, 187 (2020), <https://doi.org/10.1016/j.polymer.2019.121902>
65. Ghosal, A; Chen, K; Sinha-Ray, S.; Yarin, A., and Pourdeyhimi, B., "Modeling Polymer Crystallization Kinetics in Meltblowing Process", (2019), *Industrial & Engineering Chemistry Research*, 59(1), 399–412.
66. Zhang, W, Yarin, A.L, and Pourdeyhimi, B., "Cohesion energy of thermally-bonded polyethylene terephthalate nonwovens - Experiments and theory", (2019), *Polymer Testing* 78, <https://doi.org/10.1016/j.polymertesting.2019.105984>
67. Yousefi, S. H., Tang, C., Vahedi Tafreshi, H., and Pourdeyhimi, B. (2019), "Empirical Model To Simulate Morphology of Electrospun Polycaprolactone Mats", *Journal of Applied Polymer Science*, 2019, DOI: 10.1002/APP.48242.
68. Jamali, M., Tafreshi, H., and Pourdeyhimi, B. (2019). Penetration of liquid droplets into hydrophobic fibrous materials under enhanced gravity, *J. Appl. Phys.* 125, 14530 <https://doi.org/10.1063/1.5092227>.
69. Lia, G., Staszela, C., Yarin, A. Pourdeyhimi, B. (2019). Hydroentanglement of polymer nonwovens. 1: Experimental and theoretical/numerical framework, *Polymer* 164, 191-204.
70. Lia, G., Staszela, C., Yarin, A. Pourdeyhimi, B. (2019). Hydroentanglement of Polymer Nonwovens 2: Simulation of multiple polymer fibers and prediction of entanglement, *Polymer* 164, 191-204.
71. Tabor, J., Wust, K., and Pourdeyhimi, B. (2019), The role of staple fiber length on the performance of carded, hydroentangled nonwovens produced with splittable fibers. *Journal of Engineered Fibers and Fabrics*. January 2019. doi:[10.1177/1558925019832526](https://doi.org/10.1177/1558925019832526)
72. Phalak, S., Shim, E., and Pourdeyhimi, B. (2018). Meltblown Structure-Property Relationships: Permeability & Barrier Properties, *Journal of Engineered Fibers and Fabrics*, In Press.
73. Cai, S. B., Pourdeyhimi, B., & Lobo, E. G. (2018). Industrial-Scale Fabrication of an Osteogenic and Antibacterial PLA/Silver-Loaded Calcium Phosphate Composite with Significantly Reduced Cytotoxicity, *Journal of Biomedical Materials Research, B Part B*, 2018:000B:1–11.
74. Pan, Q., Tong, N. J., He, N. F., Liu, Y. X., Shim, E. Y., Pourdeyhimi, B., & Gao, W. (2018). Electrospun mat of poly (vinyl alcohol)/graphene oxide for superior electrolyte performance. *ACS Applied Materials & Interfaces*, 10(9), 7927-7934.
75. Yasar Kiyak, Benoît Mazé & Behnam Pourdeyhimi (2019) Microfiber Nonwovens as Potential Membranes, *Separation & Purification Reviews*, 48:4, 282 297, DOI: [10.1080/15422119.2018.1479968](https://doi.org/10.1080/15422119.2018.1479968)
76. Tabor J, Wust C, Pourdeyhimi B. The role of staple fiber length on the performance of carded, hydroentangled nonwovens produced with splittable fibers. *Journal of Engineered Fibers and Fabrics*. January 2019. doi:[10.1177/1558925019832526](https://doi.org/10.1177/1558925019832526)

77. Pan, Q., Tong, N. J., He, N. F., Liu, Y. X., Shim, E. Y., Pourdeyhimi, B., & Gao, W. (2018). Electrospun mat of poly(vinyl alcohol)/graphene oxide for superior electrolyte performance. *ACS Applied Materials & Interfaces*, 10(9), 7927-7934.
78. Staszal, C., Yarin, A. L., & Pourdeyhimi, B. (2018). Polymer adhesion in heat-treated nonwovens. *Journal of Applied Polymer Science*, 135(15).
79. Staszal, C., Zhang, W., Shim, E., Pourdeyhimi, B., and Yarin, A., (2018). Point-Bonded Polymer Nonwovens and Their Rupture in Stretching, *Polymer*, Volume 146, 20 June 2018, Pages 209-221.
80. Staszal, C., Sinha-Ray, S., Yarin, A. L., & Pourdeyhimi, B. (2017). Adhesion of blended polymer films. *Polymer*, 112, 92-101.
81. Amid, H., Maze, B., Flickinger, M. C., & Pourdeyhimi, B. (2017). Dynamic adsorption of ammonia: Apparatus, testing conditions, and adsorption capacities. *Measurement Science & Technology*, 28(5).
82. Kolbasov, A., Sinha-Ray, S., Yarin, A. L., & Pourdeyhimi, B. (2017). Heavy metal adsorption on solution-blown biopolymer nanofiber membranes. *Journal of Membrane Science*, 530, 250-263.
83. Cai, S. B., Pourdeyhimi, B., & Lobo, E. G. (2017). High-throughput fabrication method for producing a silver-nanoparticles-doped nanoclay polymer composite with novel synergistic antibacterial effects at the material interface. *ACS Applied Materials & Interfaces*, 9(25), 21105-21115.
84. Pan, Q., Shim, E., Pourdeyhimi, B., & Gao, W. (2017). Highly conductive polypropylene-graphene nonwoven composite via interface engineering. *Langmuir*, 33(30), 7452-7458.
85. Mohiti-Asli, M., Saha, S., Murphy, S. V., Gracz, H., Pourdeyhimi, B., Atala, A., & Lobo, E. G. (2017). Ibuprofen loaded PLA nanofibrous scaffolds increase proliferation of human skin cells in vitro and promote healing of full thickness incision wounds in vivo. *Journal of Biomedical Materials Research. Part B, Applied Biomaterials*, 105(2), 327-339.
86. Mohiti-Asli, M., Risselada, M., Jacob, M., Pourdeyhimi, B., & Lobo, E. G. (2017). Creation and evaluation of new porcine model for investigation of treatments of surgical site infection. *Tissue Engineering. Part C, Methods*, 23(11), 795-803.
87. Leary, J. D., Maze, B., & Pourdeyhimi, B. (2017). Investigating activation of carbon fiber nonwovens for use as supercapacitor electrodes. *Journal of the Textile Institute*, 108(9), 1528-1536.
88. Jenkins, T. L., Meehan, S., Pourdeyhimi, B., & Little, D. (2017). Meltblown polymer fabrics as candidate scaffolds for rotator cuff tendon tissue engineering. *Tissue Engineering. Part A*, 23(17-18), 958-967.
89. Pan, Q., Shim, E., Pourdeyhimi, B., & Gao, W. (2017). Nylon-graphene composite nonwovens as monolithic conductive or capacitive fabrics. *ACS Applied Materials & Interfaces*, 9(9), 8308-8316.
90. Venu, L. B. S., Shim, E., Anantharamaiah, N., & Pourdeyhimi, B. (2017). Structures and properties of hydroentangled nonwovens: effect of number of manifolds. *Journal of the Textile Institute*, 108(3), 301-313.
91. Hassan, M. A., Anantharamaiah, N., Khan, S. A., & Pourdeyhimi, B. (2016). Computational fluid dynamics simulations and experiments of meltblown fibrous media: new die designs to enhance fiber attenuation and filtration quality. *Industrial & Engineering Chemistry Research*, 55(7), 2049-2058.
92. Tuin, S. A., Pourdeyhimi, B., & Lobo, E. G. (2016). Creating tissues from textiles: Scalable nonwoven manufacturing techniques for fabrication of tissue engineering scaffolds. *Biomedical Materials*, 11(1).
93. Mohiti-Asli, M., Molina, C., Ditepeng, T., Pourdeyhimi, B., & Lobo, E. G. (2016). Evaluation of silver ion-releasing scaffolds in a 3D coculture system of MRSA and human adipose-derived stem cells for their potential use in treatment or prevention of osteomyelitis. *Tissue Engineering. Part A*, 22(21-22), 1258-1263.
94. Hassan, M. A., Khan, S. A., & Pourdeyhimi, B. (2016). Fabrication micro-meltblown filtration media using parallel plate die design. *Journal of Applied Polymer Science*, 133(7).
95. Tuin, S. A., Pourdeyhimi, B., & Lobo, E. G. (2016). Fabrication of novel high surface area mushroom gilled fibers and their effects on human adipose derived stem cells under pulsatile fluid flow for tissue engineering applications. *Acta Biomaterialia*, 36, 220-230.

96. Amid, H., Maze, B., Flickinger, M. C., & Pourdeyhimi, B. (2016). Hybrid adsorbent nonwoven structures: a review of current technologies. *Journal of Materials Science*, 51(9), 4173-4200.
97. Kolbasov, A., Sinha-Ray, S., Joiode, A., Hassan, M. A., Brown, D., Maze, B., Pourdeyhimi, B., & Yarin, A. L. (2016). Industrial-scale solution blowing of soy protein nanofibers. *Industrial & Engineering Chemistry Research*, 55(1), 323-333.
98. Farukh, F., Demirci, E., Ali, H., Acar, M., Pourdeyhimi, B., & Silberschmidt, V. V. (2016). Nonwovens modelling: A review of finite-element strategies. *Journal of the Textile Institute*, 107(2), 225-232.
99. Ghosal, A., Sinha-Ray, S., Sinha-Ray, S., Yarin, A. L., & Pourdeyhimi, B. (2016). Numerical modeling and experimental study of solution-blown nonwovens formed on a rotating drum. *Polymer*, 105, 255-263.
100. Ghosal, A., Sinha-Ray, S., Sinha-Ray, S., Yarin, A. L., & Pourdeyhimi, B. (2016). Numerical modeling and experimental study of solution-blown nonwovens formed on a rotating drum. *Polymer*, 105, 255-263.
101. Ghosal, A., Sinha-Ray, S., Yarin, A. L., & Pourdeyhimi, B. (2016). Numerical prediction of the effect of uptake velocity on three-dimensional structure, porosity and permeability of meltblown nonwoven laydown. *Polymer*, 85, 19-27.
102. Tallury, S. S., Pourdeyhimi, B., Pasquinelli, M. A., & Spontak, R. J. (2016). Physical microfabrication of shape-memory polymer systems via bicomponent fiber spinning. *Macromolecular Rapid Communications*, 37(22), 1837-1843.
103. Leary, J. D., Hamouda, F., Maze, B., & Pourdeyhimi, B. (2016). Preparation of pseudocapacitor electrodes via electrodeposition of polyaniline on nonwoven carbon fiber fabrics. *Journal of Applied Polymer Science*, 133(16).
104. Shim, E., Pourdeyhimi, B., & Shiffler, D. (2016). Process-structure-property relationship of melt spun poly(lactic acid) fibers produced in the spunbond process. *Journal of Applied Polymer Science*, 133(47).
105. Heller, M., Wimbish, R., Gurgel, P. V., Pourdeyhimi, B., & Carbonell, R. G. (2016). Reducing diffusion limitations in Ion exchange grafted membranes using high surface area nonwovens. *Journal of Membrane Science*, 514, 53-64.
106. Staszal, C., Sett, S., Yarin, A. L., & Pourdeyhimi, B. (2016). Sintering of compound nonwovens by forced convection of hot air. *International Journal of Heat and Mass Transfer*, 101, 327-335.
107. Suvari, F., Ulcay, Y., & Pourdeyhimi, B. (2016). Sound absorption analysis of thermally bonded high-loft nonwovens. *Textile Research Journal*, 86(8), 837-847.
108. Kilic, A., Jones, K., Shim, E., & Pourdeyhimi, B. (2016). Surface crystallinity of meltspun isotactic polypropylene filaments. *Macromolecular Research*, 24(1), 25-30.
109. Saleh, A. M., Tafreshi, H. V., & Pourdeyhimi, B. (2016). An analytical approach to predict pressure drop and collection efficiency of dust-load pleated filters. *Separation and Purification Technology*, 161, 80-87.
110. Sinha-Ray, S., Sinha-Ray, S., Yarin, A. L., & Pourdeyhimi, B. (2015). Application of solution-blown 20-50 nm nanofibers in filtration of nanoparticles: The efficient van der Waals collectors. *Journal of Membrane Science*, 485, 132-150.
111. Sett, S., Lee, M. W., Weith, M., Pourdeyhimi, B., Yarin, A. L. (2015). Biodegradable and biocompatible soy protein/polymer/adhesive sticky nano-textured interfacial membranes for prevention of esca fungi invasion into pruning cuts and wounds of vines. *Journal of Materials Chemistry B*, 3(10), 2147-2162.
112. Farukh, F., Demirci, E., Acar, M., Pourdeyhimi, B., & Silberschmidt, V. V. (2015). Deformation and damage of thermally bonded nonwoven networks. *Engineering Materials*, , 181-199.
113. Kilic, A., Shim, E., & Pourdeyhimi, B. (2015). Electrostatic capture efficiency enhancement of polypropylene electret filters with barium titanate. *Aerosol Science and Technology*, 49(8), 666-673.
114. Sahu, R., Sett, S., Yarin, A. L., & Pourdeyhimi, B. (2015). Impact of aqueous suspension drops onto non-wettable porous membranes: Hydrodynamic focusing and penetration of nanoparticles. *Colloids and Surfaces. A, Physicochemical and Engineering Aspects*, 467, 31-45.

115. Kilic, A., Shim, E., & Pourdeyhimi, B. (2015). Measuring electrostatic properties of fibrous materials: A review and a modified surface potential decay technique. *Journal of Electrostatics*, 74, 21-26.
116. Farukh, F., Demirci, E., Sabuncuoglu, B., Acar, M., Pourdeyhimi, B., & Silberschmidt, V. V. (2015). Mechanical analysis of bi-component-fibre nonwovens: Finite-element strategy. *Composites. Part B. Engineering*, 68, 327-335.
117. Dasdemir, M., Maze, B., Anantharamaiah, N., Pourdeyhimi, B. (2015). Reactive compatibilization of polyamide 6/polyethylene nonwoven based thermoplastic composites. *European Polymer Journal*, 63, 194-206.
118. Sinha-Ray, S., Sinha-Ray, S., Yarin, A. L., & Pourdeyhimi, B. (2015). Theoretical and experimental investigation of physical mechanisms responsible for polymer nanofiber formation in solution blowing. *Polymer*, 56, 452-463.
119. Haslauer, C. M., Avery, M. R., Pourdeyhimi, B., & Lobo, E. G. (2015). Translating textiles to tissue engineering: Creation and evaluation of microporous, biocompatible, degradable scaffolds using industry relevant manufacturing approaches and human adipose derived stem cells. *Journal of Biomedical Materials Research. Part B, Applied Biomaterials*, 103(5), 1050-1058.
120. Kilic, A., Shim, E., Pourdeyhimi, B., & Yeom, B. Y. (2014). Aerosol filtration properties of nucleating agent containing electret filters. *Polymer Engineering and Science*, 54(7), 1533-1539.
121. Amirnasr, E., Shim, E., Yeom, B. Y., & Pourdeyhimi, B. (2014). Basis weight uniformity analysis in nonwovens. *Journal of the Textile Institute*, 105(4), 444-453.
122. Tuin, S. A., Pourdeyhimi, B., & Lobo, E. G. (2014). Interconnected, microporous hollow fibers for tissue engineering: Commercially relevant, industry standard scale-up manufacturing. *Journal of Biomedical Materials Research. Part A*, 102(9), 3311-3323.
123. Farukh, F., Demirci, E., Acar, M., Pourdeyhimi, B., & Silberschmidt, V. V. (2014). Large deformation of thermally bonded random fibrous networks: microstructural changes and damage. *Journal of Materials Science*, 49(11), 4081-4092.
124. Farukh, F., Demirci, E., Sabuncuoglu, B., Acar, M., Pourdeyhimi, B., & Silberschmidt, V. V. (2014). Mechanical behaviour of nonwovens: Analysis of effect of manufacturing parameters with parametric computational model. *Computational Materials Science*, 94, 8-16.
125. Sinha-Ray, S., Yarin, A. L., & Pourdeyhimi, B. (2014). Meltblown fiber mats and their tensile strength. *Polymer*, 55(16), 4241-4247.
126. Arambakam, R., Tafreshi, H. V., & Pourdeyhimi, B. (2014). Modeling performance of multi-component fibrous insulations against conductive and radiative heat transfer. *International Journal of Heat and Mass Transfer*, 71, 341-348.
127. Saleh, A. M., Fotovati, S., Tafreshi, H. V., & Pourdeyhimi, B. (2014). Modeling service life of pleated filters exposed to poly-dispersed aerosols. *Powder Technology*, 266, 79-89.
128. Mohiti-Asli, M., Pourdeyhimi, B., & Lobo, E. G. (2014). Novel, silver-ion-releasing nanofibrous scaffolds exhibit excellent antibacterial efficacy without the use of silver nanoparticles. *Acta Biomaterialia*, 10(5), 2096-2104.
129. Farukh, F., Demirci, E., Sabuncuoglu, B., Acar, M., Pourdeyhimi, B., & Silberschmidt, V. V. (2014). Numerical analysis of progressive damage in nonwoven fibrous networks under tension. *International Journal of Solids and Structures*, 51(9), 1670-1685.
130. Mohiti-Asli, M., Pourdeyhimi, B., & Lobo, E. G. (2014). Skin tissue engineering for the infected wound site: Biodegradable PLA nanofibers and a novel approach for silver ion release evaluated in a 3D coculture system of keratinocytes and Staphylococcus aureus. *Tissue Engineering. Part C, Methods*, 20(10), 790-797.
131. Pekmezci, B. Y., Kayaoglu, B. K., Pourdeyhimi, B., & Karadeniz, A. C. (2014). Utility of polyvinyl alcohol fiber-based needle punched nonwoven fabric as potential reinforcement in cementitious composites. *Journal of Composite Materials*, 48(25), 3129-3140.
132. Suvari, F., Ulcay, Y., Maze, B., & Pourdeyhimi, B. (2013). Acoustical absorptive properties of spunbonded nonwovens made from islands-in-the-sea bicomponent filaments. *Journal of the Textile Institute*, 104(4), 438-445.

133. Zhang, Y. Y., Lee, M. W., An, S., Sinha-Ray, S., Khansari, S., Joshi, B., Hong, S., Hong, J. H., Kim, J. J., Pourdeyhimi, B., Yoon, S. S., & Yarin, A. L. (2013). Antibacterial activity of photocatalytic electrospun titania nanofiber mats and solution-blown soy protein nanofiber mats decorated with silver nanoparticles. *Catalysis Communications*, 34, 35-40.
134. Khansari, S., Sinha-Ray, S., Yarin, A. L., & Pourdeyhimi, B. (2013). Biopolymer-based nanofiber mats and their mechanical characterization. *Industrial & Engineering Chemistry Research*, 52(43), 15104-15113.
135. Sahu, R. P., Sinha-Ray, S., Yarin, A. L., & Pourdeyhimi, B. (2013). Blowing drops off a filament. *Soft Matter*, 9(26), 6053-6071.
136. Aykut, Y., Pourdeyhimi, B., & Khan, S. A. (2013). Catalytic graphitization and formation of macroporous-activated carbon nanofibers from salt-induced and H₂S-treated polyacrylonitrile. *Journal of Materials Science*, 48(22), 7783-7790.
137. Farukh, F., Demirci, E., Sabuncuoglu, B., Acar, M., Pourdeyhimi, B., & Silberschmidt, V. V. (2013). Characterisation and numerical modelling of complex deformation behaviour in thermally bonded nonwovens. *Computational Materials Science*, 71, 165-171.
138. Kilic, A., Shim, E., Yeom, B. Y., & Pourdeyhimi, B. (2013). Effect of DMDBS (3: 2, 4-bis(3,4-dimethyldibenzylidene) sorbitol) and NA11 (sodium 2,2-methylene-bis(4,6-di-tertbutylphenyl)-phosphate) on electret properties of polypropylene filaments. *Journal of Applied Polymer Science*, 130(3), 2068-2075.
139. Aykut, Y., Pourdeyhimi, B., & Khan, S. A. (2013). Effects of surfactants on the microstructures of electrospun polyacrylonitrile nanofibers and their carbonized analogs. *Journal of Applied Polymer Science*, 130(5), 3726-3735.
140. Hassan, M. A., Yeom, B. Y., Wilkie, A., Pourdeyhimi, B., & Khan, S. A. (2013). Fabrication of nanofiber meltblown membranes and their filtration properties. *Journal of Membrane Science*, 427, 336-344.
141. Kilic, A., Shim, E., Yeom, B. Y., & Pourdeyhimi, B. (2013). Improving electret properties of PP filaments with barium titanate. *Journal of Electrostatics*, 71(1), 41-47.
142. Farukh, F., Demirci, E., Acar, M., Pourdeyhimi, B., & Silberschmidt, V. V. (2013). Meso-scale deformation and damage in thermally bonded nonwovens. *Journal of Materials Science*, 48(6), 2334-2345.
143. Das, D., Ishtiaque, S. M., Rao, S. V. A., & Pourdeyhimi, B. (2013). Modelling and experimental studies of air permeability of nonuniform nonwoven fibrous porous media. *Fibers and Polymers*, 14(3), 494-499.
144. Honarbakhsh, S., Guenther, R. H., Willoughby, J. A., Lommel, S. A., & Pourdeyhimi, B. (2013). Polymeric systems incorporating plant viral nanoparticles for tailored release of therapeutics. *Advanced Healthcare Materials*, 2(7), 1001-1007.
145. Sinha-Ray, S., Yarin, A. L., & Pourdeyhimi, B. (2013). Prediction of angular and mass distribution in meltblown polymer lay-down. *Polymer*, 54(2), 860-872.
146. Canbolat, M. F., Gera, N., Tang, C., Monian, B., Rao, B. M., Pourdeyhimi, B., & Khan, S. A. (2013). Preservation of cell viability and protein conformation on immobilization within nanofibers via electrospinning functionalized yeast. *ACS Applied Materials & Interfaces*, 5(19), 9349-9354.
147. Sinha-Ray, S., Lee, M. W., Sinha-Ray, S., An, S., Pourdeyhimi, B., Yoon, S. S., & Yarin, A. L. (2013). Supersonic nanoblowing: a new ultra-stiff phase of nylon 6 in 20-50 nm confinement. *Journal of Materials Chemistry C*, 1(21), 3491-3498.
148. Aykut, Y., Pourdeyhimi, B., & Khan, S. A. (2013). Synthesis and characterization of silver/lithium cobalt oxide (Ag/LiCoO₂) nanofibers via sol-gel electrospinning. *Journal of Physics and Chemistry of Solids*, 74(11), 1538-1545.
149. Aykut, Y., Parsons, G. N., Pourdeyhimi, B., & Khan, S. A. (2013). Synthesis of mixed ceramic Mg_xZn_{1-x}O nanofibers via Mg²⁺ doping using sol-gel electrospinning. *Langmuir*, 29(12), 4159-4166.
150. Khansari, S., Duzyer, S., Sinha-Ray, S., Hockenberger, A., Yarin, A. L., & Pourdeyhimi, B. (2013). Two-stage desorption-controlled release of fluorescent dye and vitamin from solution-blown and electrospun nanofiber mats containing porogens. *Molecular Pharmaceutics*, 10(12), 4509-4526.

151. Zhu, S., So, J. H., Mays, R., Desai, S., Barnes, W. R., Pourdeyhimi, B., & Dickey, M. D. (2013). Ultrastretchable fibers with metallic conductivity using a liquid metal alloy core. *Advanced Functional Materials*, 23(18), 2308-2314.
152. Farukh, F., Demirci, E., Sabuncuoglu, B., Acar, M., Pourdeyhimi, B., & Silberschmidt, V. V. (2012). Numerical modelling of damage initiation in low-density thermally bonded nonwovens. (*Computational Materials Science*, 64) (pp. 112-115).
153. Das, D., Pradhan, A. K., & Pourdeyhimi, B. (2012). Dependence of the liquid absorption behavior of nonwovens on their material and structural characteristics: Modeling and experiments. *Journal of Applied Polymer Science*, 126(3), 1053-1060.
154. Sahu, R. P., Sinha-Ray, S., Yarin, A. L., & Pourdeyhimi, B. (2012). Drop impacts on electrospun nanofiber membranes. *Soft Matter*, 8(14), 3957-3970.
155. Dasdemir, M., Maze, B., Anantharamaiah, N., & Pourdeyhimi, B. (2012). Influence of polymer type, composition, and interface on the structural and mechanical properties of core/sheath type bicomponent nonwoven fibers. *Journal of Materials Science*, 47(16), 5955-5969.
156. Asli, M. M., Pourdeyhimi, B., & Lobo, E. G. (2012). Release profiles of tricalcium phosphate nanoparticles from Poly(L-lactic acid) electrospun scaffolds with single component, core-sheath, or porous fiber morphologies: Effects on hASC viability and osteogenic differentiation. *Macromolecular Bioscience*, 12(7), 893-900.
157. Jung, K. H., Pourdeyhimi, B., & Zhang, X. W. (2012). Selective permeation of cross-linked polyelectrolyte and polyelectrolyte-filled nonwoven membranes. *Journal of Applied Polymer Science*, 123(1), 227-233.
158. Khansari, S., Sinha-Ray, S., Yarin, A. L., & Pourdeyhimi, B. (2012). Stress-strain dependence for soy-protein nanofiber mats. *Journal of Applied Physics*, 111(4).
159. Datla, V., Shim, E., & Pourdeyhimi, B. (2012). Surface modifications of polypropylene with nonylphenol ethoxylates melt additives. *Polymer Engineering and Science*, 52(9), 1920-1927.
160. Aykut, Y., Saquing, C. D., Pourdeyhimi, B., Parsons, G. N., & Khan, S. A. (2012). Templating quantum dot to phase-transformed electrospun TiO₂ nanofibers for enhanced photo-excited electron injection. *ACS Applied Materials & Interfaces*, 4(8), 3837-3845.
161. Venu, L. B. S., Shim, E., Anantharamaiah, N., & Pourdeyhimi, B. (2012). Three-dimensional structural characterization of nonwoven fabrics. *Microscopy and Microanalysis*, 18(6), 1368-1379.
162. Demirci, E., Acar, M., Pourdeyhimi, B., & Silberschmidt, V. V. (2011). Finite element modelling of thermally bonded bicomponent fibre nonwovens: Tensile behaviour. (*Computational Materials Science*, 50 4) (pp. 1286-1291).
163. Yeom, B. Y., & Pourdeyhimi, B. (2011). Aerosol filtration properties of PA6/PE islands-in-the-sea bicomponent spunbond web fibrillated by high-pressure water jets. *Journal of Materials Science*, 46(17), 5761-5767.
164. Fotovati, S., Tafreshi, H. V., & Pourdeyhimi, B. (2011). Analytical expressions for predicting performance of aerosol filtration media made up of trilobal fibers. *Journal of Hazardous Materials*, 186(2-3), 1503-1512.
165. McCullen, S. D., Gittard, S. D., Miller, P. R., Pourdeyhimi, B., Narayan, R. J., & Lobo, E. G. (2011). Laser ablation imparts controlled micro-scale pores in electrospun scaffolds for tissue engineering applications. *Annals of Biomedical Engineering*, 39(12), 3021-3030.
166. Canbolat, M. F., Tang, C., Bernacki, S. H., Pourdeyhimi, B., & Khan, S. (2011). Mammalian cell viability in electrospun composite nanofiber structures. *Macromolecular Bioscience*, 11(10), 1346-1356.
167. Yarin, A. L., Sinha-Ray, S., & Pourdeyhimi, B. (2011). Meltblowing: Multiple polymer jets and fiber-size distribution and lay-down patterns. *Polymer*, 52(13), 2929-2938.
168. Fotovati, S., Hosseini, S. A., Tafreshi, H. V., & Pourdeyhimi, B. (2011). Modeling instantaneous pressure drop of pleated thin filter media during dust loading. *Chemical Engineering Science*, 66(18), 4036-4046.

169. Arambakam, R., Hosseini, S. A., Tafreshi, H. V., & Pourdeyhimi, B. (2011). A Monte Carlo simulation of radiative heat through fibrous media: Effects of boundary conditions and microstructural parameters. *International Journal of Thermal Sciences*, 50(6), 935-941.
170. Datla, V. M., Shim, E., & Pourdeyhimi, B. (2011). Polypropylene surface modification with stearyl alcohol ethoxylates to enhance wettability. *Journal of Applied Polymer Science*, 121(3), 1335-1347.
171. Honarbakhsh, S., & Pourdeyhimi, B. (2011). Scaffolds for drug delivery, part I: Electrospun porous poly(lactic acid) and poly(lactic acid)/poly(ethylene oxide) hybrid scaffolds. *Journal of Materials Science*, 46(9), 2874-2881.
172. Sinha-Ray, S., Zhang, Y., Yarin, A. L., Davis, S. C., & Pourdeyhimi, B. (2011). Solution blowing of soy protein fibers. *Biomacromolecules*, 12(6), 2357-2363.
173. Rangasamy, L., Shim, E., & Pourdeyhimi, B. (2011). Structure and tensile properties of nanoclay-polypropylene fibers produced by melt spinning. *Journal of Applied Polymer Science*, 121(1), 410-419.
174. Jung, K. H., Pourdeyhimi, B., & Zhang, X. W. (2011). Synthesis and characterization of polymer-filled nonwoven membranes. *Journal of Applied Polymer Science*, 119(5), 2568-2575.
175. Yeom, B. Y., & Pourdeyhimi, B. (2011). Web fabrication and characterization of unique winged shaped, area-enhanced fibers via a bicomponent spunbond process. *Journal of Materials Science*, 46(10), 3252-3257.
176. Fotovati, S., Tafreshi, H. V., Ashari, A., Hosseini, S. A., & Pourdeyhimi, B. (2010). Analytical expressions for predicting capture efficiency of bimodal fibrous filters. *Journal of Aerosol Science*, 41(3), 295-305.
177. Yeom, B. Y., Shim, E., & Pourdeyhimi, B. (2010). Boehmite nanoparticles incorporated electrospun nylon-6 nanofiber web for new electret filter media. *Macromolecular Research*, 18(9), 884-890.
178. Jung, K. H., Pourdeyhimi, B., & Zhang, X. W. (2010). Chemical protection performance of polystyrene sulfonic acid-filled polypropylene nonwoven membranes. *Journal of Membrane Science*, 362(1-2), 137-142.
179. Das, D., & Pourdeyhimi, B. (2010). Compressional and recovery behaviour of highloft nonwovens. *Indian Journal of Fibre & Textile Research*, 35(4), 303-309.
180. Wong, K. C., Haslauer, C. M., Anantharamaiah, N., Pourdeyhimi, B., Batchelor, A. D., & Griffis, D. P. (2010). Focused ion beam characterization of bicomponent polymer fibers. *Microscopy and Microanalysis*, 16(3), 282-290.
181. McCullen, S. D., Miller, P. R., Gittard, S. D., Gorga, R. E., Pourdeyhimi, B., Narayan, R. J., & Lobo, E. G. (2010). In situ collagen polymerization of layered cell-seeded electrospun scaffolds for bone tissue engineering applications. *Tissue Engineering. Part C, Methods*, 16(5), 1095-1105.
182. Fotovati, S., Tafreshi, H. V., & Pourdeyhimi, B. (2010). Influence of fiber orientation distribution on performance of aerosol filtration media. *Chemical Engineering Science*, 65(18), 5285-5293.
183. Sumanasinghe, R. D., Haslauer, C. M., Pourdeyhimi, B., & Lobo, E. G. (2010). Melt spun microporous fibers using poly(lactic acid) and sulfonated copolyester blends for tissue engineering applications. *Journal of Applied Polymer Science*, 117(6), 3350-3361.
184. Sinha-Ray, S., Yarin, A. L., & Pourdeyhimi, B. (2010). Meltblowing: I-basic physical mechanisms and threadline model. *Journal of Applied Physics*, 108(3).
185. Yarin, A. L., Sinha-Ray, S., & Pourdeyhimi, B. (2010). Meltblowing: II-linear and nonlinear waves on viscoelastic polymer jets. *Journal of Applied Physics*, 108(3).
186. Tahir, M. A., Tafreshi, H. V., Hosseini, S. A., & Pourdeyhimi, B. (2010). Modeling the role of microstructural parameters in radiative heat transfer through disordered fibrous media. *International Journal of Heat and Mass Transfer*, 53(21-22), 4629-4637.
187. Datla, V. M., Beck, K., Shim, E., & Pourdeyhimi, B. (2010). Reverse phase HPLC analysis of commercial surfactants used as melt additives. *Tenside, Surfactants, Detergents*, 47(3), 142-150.
188. Jung, K. H., Ji, L. W., Pourdeyhimi, B., & Zhang, X. W. (2010). Structure-property relationships of polymer-filled nonwoven membranes for chemical protection applications. *Journal of Membrane Science*, 361(1-2), 63-70.

189. Shim, E., Pourdeyhimi, B., & Latifi, M. (2010). Three-dimensional analysis of segmented pie bicomponent nonwovens. *Journal of the Textile Institute*, 101(9), 773-787.
190. Talwar, S., Krishnan, A. S., Hinestroza, J. P., Pourdeyhimi, B., & Khan, S. A. (2010). electrospun nanofibers with associative polymer-surfactant systems. *Macromolecules*, 43(18), 7650-7656.
191. Sinha-Ray, S., Yarin, A. L., & Pourdeyhimi, B. (2010). The production of 100/400 nm inner/outer diameter carbon tubes by solution blowing and carbonization of core-shell nanofibers. *Carbon*, 48(12), 3575-3578.
192. Tafreshi, H. V., Rahman, M. S. A., Jaganathan, S., Wang, Q., & Pourdeyhimi, B. (2009). Analytical expressions for predicting permeability of bimodal fibrous porous media. *Chemical Engineering Science*, 64(6), 1154-1159.
193. Begenir, A., Michielsen, S., & Pourdeyhimi, B. (2009). Crystallization behavior of elastomeric block copolymers: Thermoplastic polyurethane and polyether-block-amide. *Journal of Applied Polymer Science*, 111(3), 1246-1256.
194. Anantharamaiah, N., Verenich, S., & Pourdeyhimi, B. (2009). Durable nonwoven fabrics via fracturing bicomponent Islands-in-the-Sea filaments. *AATCC Review*, 9(2), 41-47.
195. McCullen, S. D., Zhu, Y., Bernacki, S. H., Narayan, R. J., Pourdeyhimi, B., Gorga, R. E., & Lobo, E. G. (2009). Electrospun composite poly(L-lactic acid)/tricalcium phosphate scaffolds induce proliferation and osteogenic differentiation of human adipose-derived stem cells. *Biomedical Materials*, 4(3).
196. Karaguzel, B., Merritt, C. R., Kang, T., Wilson, J. M., Nagle, H. T., Grant, E., & Pourdeyhimi, B. (2009). Flexible, durable printed electrical circuits. *Journal of the Textile Institute*, 100(1), 1-9.
197. Durany, A., Anantharamaiah, N., & Pourdeyhimi, B. (2009). High surface area nonwovens via fibrillating spunbonded nonwovens comprising Islands-in-the-Sea bicomponent filaments: structure-process-property relationships. *Journal of Materials Science*, 44(21), 5926-5934.
198. Begenir, A., Michielsen, S., & Pourdeyhimi, B. (2009). Melt-blowing thermoplastic polyurethane and polyether-block-amide elastomers: Effect of processing conditions and crystallization on web properties. *Polymer Engineering and Science*, 49(7), 1340-1349.
199. Qashou, I., Tafreshi, H. V., & Pourdeyhimi, B. (2009). An investigation of the radiative heat transfer through nonwoven fibrous materials. *Journal of Engineered Fibers and Fabrics*, 4(1), 9-15.
200. Jaganathan, S., Tafreshi, H. V., & Pourdeyhimi, B. (2009). A realistic modeling of fluid infiltration in thin fibrous sheets. *Journal of Applied Physics*, 105(11).
201. Jaganathan, S., Tafreshi, H. V., Shim, E., & Pourdeyhimi, B. (2009). A study on compression-induced morphological changes of nonwoven fibrous materials. *Colloids and Surfaces. A, Physicochemical and Engineering Aspects*, 337(1-3), 173-179.
202. Talwar, S., Hinestroza, J., Pourdeyhimi, B., & Khan, S. A. (2008). Associative polymer facilitated electrospinning of nanofibers. *Macromolecules*, 41(12), 4275-4283.
203. Paul, S., Verenich, S., & Pourdeyhimi, B. (2008). Blending polypropylene with glycidyl methacrylate-containing polymer to improve adhesion to elastomers. *Polymer International*, 57(8), 975-981.
204. Verenich, S., Paul, S., & Pourdeyhimi, B. (2008). Surface and Bulk Properties of Glycidyl Methacrylate Modified Polypropylene: Experimental and Molecular Modeling Studies. *Journal of Applied Polymer Science*, Vol. 108, 2983-2987 (2008)
205. Maze, B., Tafreshi, H. V., & Pourdeyhimi, B. (2008). Case studies of air filtration at microscales: Micro- and nanofiber media. *Journal of Engineered Fibers and Fabrics*, 3(2).
206. Pourdeyhimi, B. (2008). Comments on the paper entitled Splitting of Islands-in-the-Sea Fibers (PA6/COPET) during hydroentangling of nonwovens. *Journal of Engineered Fibers and Fabrics*, 3(1), 32-35.
207. Kang, T. H., Merritt, C. R., Grant, E., Pourdeyhimi, B., & Nagle, H. T. (2008). Nonwoven fabric active electrodes for biopotential measurement during normal daily activity. *IEEE Transactions on Biomedical Engineering*, 55(1), 188-195.
208. Gupta, G., Rajagopalan, A., Pourdeyhimi, B., & Lazzi, G. (2008). On the use of vector antennas embedded on fabric as frequency selective surfaces. In 2008 IEEE International Symposium on

- Antennas and Propagation and USNC/URSI National Radio Science Meeting. (pp. 1208-1211). [Piscataway, NJ]: IEEE.
209. Jaganathan, S., Tafreshi, H. V., & Pourdeyhimi, B. (2008). On the pressure drop prediction of filter media composed of fibers with bimodal diameter distributions. *Powder Technology*, 181(1), 89-95.
 210. Karaguzel, B., Tafreshi, H. V., & Pourdeyhimi, B. (2008). Potentials and challenges in jetting microdroplets onto nonwoven fabrics. *Journal of the Textile Institute*, 99(6), 581-589.
 211. Jaganathan, S., Maze, B., Tafreshi, H. V., & Pourdeyhimi, B. (2008). Simulating liquid flow through virtual glass fiber mats. *Textile Research Journal*, 78(10), 903-910.
 212. Verenich, S., Arumugam, K., Shim, E., & Pourdeyhimi, B. (2008). Treatment of raw cotton fibers with cellulases for nonwoven fabrics. *Textile Research Journal*, 78(6), 540-548.
 213. Karaguzel, B., Merritt, C. R., Kang, T., Wilson, J. M., Nagle, H. T., Grant, E., & Pourdeyhimi, B. (2008). Utility of nonwovens in the production of integrated electrical circuits via printing conductive inks. *Journal of the Textile Institute*, 99(1), 37-45.
 214. Jaganathan, S., Tafreshi, H. V., & Pourdeyhimi, B. (2008). The influence of forming surface on the vacuum pressure in hydroentangling process. *Journal of the Textile Institute*, 99(5), 407-414.
 215. Latifi, M., Tafreshi, H. V., & Pourdeyhimi, B. (2008). A note on an optical method to evaluate fiber dispersion in wet-laid nonwoven process. *Textile Research Journal*, 78(6), 518-523.
 216. Pourdeyhimi, B. (2007). Future directions in nonwovens technologies. *Beltwide Cotton Conferences. Proceedings*.
 217. Pourdeyhimi, B. (2007). High performance nonwovens. (*Beltwide Cotton Conferences. Proceedings*,).
 218. Pourdeyhimi, B. (2007). Opportunities for cotton. (*Beltwide Cotton Conferences. Proceedings*,).
 219. Pourdeyhimi, B., Tafreshi, H. V., & Maze, B. (2007). 3-D simulation and analysis of nonwoven structures. *Journal of Engineered Fibers and Fabrics*, 1(2), 47-52.
 220. Hanson, A. D., Wall, M. E., Pourdeyhimi, B., & Lobo, E. G. (2007). Effects of oxygen plasma treatment on adipose-derived human mesenchymal stem cell adherence to poly(L-lactic acid) scaffolds. *Journal of Biomaterials Science, Polymer Edition*, 18(11), 1387-1400.
 221. Maze, B., Tafreshi, H. V., & Pourdeyhimi, B. (2007). Geometrical modeling of fibrous materials under compression. *Journal of Applied Physics*, 102(7).
 222. Fedorova, N., & Pourdeyhimi, B. (2007). High strength nylon micro- and nanofiber based nonwovens via spunbonding. *Journal of Applied Polymer Science*, 104(5), 3434-3442.
 223. Wang, Q., Maze, B., Tafreshi, H. V., & Pourdeyhimi, B. (2007). On the pressure drop modeling of monofilament-woven fabrics. *Chemical Engineering Science*, 62(17), 4817-4821.
 224. Anantharamaiah, N., Tafreshi, H. V., & Pourdeyhimi, B. (2007). Predicting inlet roundness of hydroentangling nozzles via CFD simulations. *Journal of Micromechanics and Microengineering*, 17(5), N31.
 225. Arumugam, K., Verenich, S., Shim, E., & Pourdeyhimi, B. (2007). Pretreatment of bleached cotton fibers with whole and Monocomponent cellulases for nonwoven applications. *Textile Research Journal*, 77(10), 734-742.
 226. Zobel, S., Maze, B., Tafreshi, H. V., Wang, Q., & Pourdeyhimi, B. (2007). Simulating permeability of 3-D calendered fibrous structures. *Chemical Engineering Science*, 62(22), 6285-6296.
 227. Wang, Q., Maze, B., Tafreshi, H. V., & Pourdeyhimi, B. (2007). Simulating through-plane permeability of fibrous materials with different fiber lengths. *Modelling and Simulation in Materials Science and Engineering*, 15(8), 855-868.
 228. Fedorova, N., Verenich, S., & Pourdeyhimi, B. (2007). Strength optimization of thermally bonded spunbond nonwovens. *Journal of Engineered Fibers and Fabrics*, 2(1), 38-48.
 229. Anantharamaiah, N., Rompert, K., Tafreshi, H. V., & Pourdeyhimi, B. (2007). A novel nozzle design for producing hydroentangled nonwoven materials with minimum jet-mark defects. *Journal of Materials Science*, 42(15), 6161-6170.
 230. Anantharamaiah, N., Tafreshi, H. V., & Pourdeyhimi, B. (2007). A simple expression for predicting the inlet roundness of micro-nozzles. *Journal of Micromechanics and Microengineering*, 17(5), N31-N39.

231. Maze, B., Tafreshi, H. V., Wang, Q., & Pourdeyhimi, B. (2007). A simulation of un-steady-state filtration via nanofiber media at reduced operating pressures. *Journal of Aerosol Science*, 38(5), 550-571.
232. Anantharamaiah, N., Rompert, K., Vahedi Tafreshi, H., & Pourdeyhimi, B. (2007). A study on the role of hydroentangling waterjets in reorienting fibers in nonwoven fabrics. *Journal of Materials Science*, 42, 6161-6170.
233. Tafreshi, H. V., Ercan, E., & Pourdeyhimi, B. (2006). Calculating mass transfer from vertical wet fabrics using a free convection heat transfer correlation. *Heat and Mass Transfer*, 42(9), 767-769.
234. Semnani, D., Latifi, M., Tehran, M. A., Pourdeyhimi, B., & Merati, A. A. (2006). Grading of yarn appearance using image analysis and an artificial intelligence technique. *Textile Research Journal*, 76(3), 187-196.
235. Pourdeyhimi, B., & Maze, B. (2006). Modeling mechanical properties of thermally bonded nonwovens.
236. Pourdeyhimi, B. (2006). New innovations in engineered fabrics. In Innovations in medical, protective, and technical textiles: AATCC symposium ; February 1 - 2, 2006, Embassy Suites Hotel, Cary, North Carolina. Research Triangle Park, NC: AATCC.
237. Pourdeyhimi, B., & Shim, E. (2006). Hydroentangling fabrics for improving abrasion resistance. *Journal of the Textile Institute*, 97(5), 435-440.
238. Shim, E., & Pourdeyhimi, B. (2006). Hydroentangling knitted fabrics for improving abrasion resistance. *Journal of the Textile Institute*, 97(5), 435-440.
239. Pourdeyhimi, B., Tafreshi, H., & Anantharamaiah, N. (2006). Numerical simulation of the formation of constricted waterjets in capillary nozzles: Effects of nozzle geometry. *Chemical Engineering Research & Design*, 84(A3), 231-238.
240. Zapletalova, T., Michielsen, S. & Pourdeyhimi, B. (2006). Polyether based thermoplastic polyurethane melt blown nonwovens. *Journal of Engineered Fibers and Fabrics*, 1(1).
241. Michielsen, S., Pourdeyhimi, B., & Desai, P. (2006). Review of thermally point-bonded nonwovens: Materials, processes, and properties. *Journal of Applied Polymer Science*, 99(5), 2489-2496.
242. Wang, Q., Maze, B., Tafreshi, H. V., & Pourdeyhimi, B. (2006). A case study of simulating submicron aerosol filtration via lightweight spun-bonded filter media. *Chemical Engineering Science*, 61(15), 4871-4883.
243. Wang, Q., Maze, B., Tafreshi, H. V., & Pourdeyhimi, B. (2006). A note on permeability simulation of multifilament woven fabrics. *Chemical Engineering Science*, 61(24), 8085-8088.
244. Pourdeyhimi, B., Wang, Q., Maze, B., & Tafreshi, H. V. (2006). A note on the permeability of multifilament woven fabrics. *Chemical Engineering Science*, 61, 8085-8088.
245. Pourdeyhimi, B., Tafreshi, H., & Anantharamaiah, N. (2006). A study on deterioration of hydroentangling nozzles due to erosion and particle accretion. *Chemical Engineering Science*, 61, 4582-4594.
246. Anantharamaiah, N., Tafreshi, H. V., & Pourdeyhimi, B. (2006). A study on flow through hydroentangling nozzles and their degradation. *Chemical Engineering Science*, 61(14), 4582-4594.
247. Pourdeyhimi, B., Tafreshi, H., & Anantharamaiah, N. (2006). A study on hydroentangling waterjets and their impact force. *Experiments in Fluids*, 41, 103-113.
248. Anantharamaiah, N., Tafreshi, H. V., & Pourdeyhimi, B. (2006). A study on hydroentangling waterjets and their impact forces. *Experiments in Fluids*, 41(1), 103-113.
249. Pourdeyhimi, B., Semnani, D., Latifi, M., Tehran, M. A., & Merati, A. A. (2005). Development of appearance grading method of cotton yarns for various types of yarns. *Research Journal of Textile & Apparel*, 9(4), 886-893.
250. Ulcay, Y., & Pourdeyhimi, B. (2005). Effect of dilation on the mechanical characterization of vascular prostheses. *Fibers and Polymers*, 6(1), 49-54.
251. Pourdeyhimi, B., & Ulcay, Y. (2005). Effect of dilation on the mechanical properties of vascular grafts. *Fibers and Polymers*, 6(1), 49-54.

252. Pourdeyhimi, B., Semnani, D., Latifi, M., Tehran, M. A., & Merati, A. A. (2005). Effect of yarn appearance on apparent quality of weft knitted fabrics. *Journal of the Textile Institute*, 96(5), 295-301.
253. R. Garcia, N. Federova, V. Knowlton, C. Oldham, B. & Pourdeyhimi. (2005). Sample preparation for textile nanofiber composites. *Microscopy Today*, 13(2), 38-40.
254. Shim, E., & Pourdeyhimi, B. (2005). A note on jet streaks in hydroentangled nonwovens. *Textile Research Journal*, 75(7), 569-577.
255. Pourdeyhimi, B., & Tafreshi, H. (2004). Cavitation and hydraulic flip. *Fluent news: Newsletter*, 13(1), 38.
256. Begenir, A., Tafreshi, H. V., & Pourdeyhimi, B. (2004). Effect of nozzle geometry on hydroentangling water jets: Experimental observations. *Textile Research Journal*, 74(2), 178-184.
257. Begenir, A., Tafreshi, H., & Pourdeyhimi, B. (2004). Effect of nozzle geometry on hydroentangling waterjets: Experimental observations. *Textile Research Journal*, 74(2), 178-184.
258. Pourdeyhimi, B. (2004). ITMA 2003 review: Nonwovens. *Textile World (New York, N.Y.)*, 154(2).
259. Shim, E., Pourdeyhimi, B., & Little, T. J. (2004). Luminescence and mechanical properties of photoluminescent core bicomponent fibers. *Textile Research Journal*, 74(11), 982-988.
260. Pourdeyhimi, B. (2004). Nonwovens and traditional textile know-how. *Textile World (New York, N.Y.)*, 154(8).
261. Tafreshi, H. V., & Pourdeyhimi, B. (2004). Simulating cavitation and hydraulic flip inside hydroentangling nozzles. *Textile Research Journal*, 74(4), 359-364.
262. Tafreshi, H., & Pourdeyhimi, B. (2004). Simulating of cavitation and hydraulic flip inside hydroentangling nozzles. *Textile Research Journal*, 74(4), 359-364.
263. Pourdeyhimi, B., Minton, A., Putnam, M., & Kim, H. S. (2004). Structure-process-property relationships in hydroentangled nonwovens - part 1: Preliminary experimental observations. *International Nonwovens Journal*, 13(4), 15-22.
264. Tafreshi, H., and Pourdeyhimi, B. (2004). Cavitation and Hydraulic Flip, *Fluent News*, 13(1), 38, 2004.
265. Tafreshi, H., & Pourdeyhimi, B. (2003). Cavitation in hydroentangling orifices. In INTC 2003: International Nonwovens Technical Conference: conference proceedings: September 15-18, 2003, Renaissance Harborplace Hotel, Baltimore, Maryland. Atlanta, Ga.: Tappi Press.
266. Michielsen, S., Pourdeyhimi, B., & Desai, P. (2003). Review of thermally point bonded nonwovens: Materials, processes and properties. In INTC 2003: International Nonwovens Technical Conference: conference proceedings: September 15-18, 2003, Renaissance Harborplace Hotel, Baltimore, Maryland. Atlanta, Ga.: Tappi Press.
267. Pourdeyhimi, B. (2003). Scratch and mar brought about by wipes. In INTC 2003: International Nonwovens Technical Conference: conference proceedings: September 15-18, 2003, Renaissance Harborplace Hotel, Baltimore, Maryland. Atlanta, Ga.: Tappi Press.
268. Pourdeyhimi, B. (2003). Structure-process-property relationship in hydroentangled nonwovens. In INTC 2003: International Nonwovens Technical Conference: conference proceedings : September 15-18, 2003, Renaissance Harborplace Hotel, Baltimore, Maryland. Cary, N.C.: INDIA, Association of the Nonwoven Fabrics Industry.
269. Tafreshi, H., Begenir, A., & Pourdeyhimi, B. (2003). The role of orifice geometry on hydroentangling: Experimental observations. In INTC 2003: International Nonwovens Technical Conference: conference proceedings: September 15-18, 2003, Renaissance Harborplace Hotel, Baltimore, Maryland. Atlanta, Ga.: Tappi Press.
270. Lee, F., Pourdeyhimi, B., Hazzard, C., & Summerville, J. (2003). Analysis of coatings appearance and durability testing induced surface defects using image capture/processing/analysis. *Revista De Metalurgia*, (2003), 206-212.
271. Pourdeyhimi, B., Sikkema, D., & Northolt, M. (2003). Assessment of new high-performance fibers for advanced applications. *MRS Bulletin*, 8(8).

272. Sikkema, D. J., Northolt, M. G., & Pourdeyhimi, B. (2003). Assessment of new high-performance fibers for advanced applications. *MRS Bulletin*, 28(8), 579-584.
273. Kim, H. S., & Pourdeyhimi, B. (2003). In-plane liquid distribution in nonwoven fabrics part II: Simulation. *International Nonwovens Journal*, 12(2).
274. Pourdeyhimi, B. (2003). Italian textile technology - machines Italia: Nonwovens. *Textile World (New York, N.Y.)*, 153(6).
275. Zamfir, M., McCulloch, J., & Pourdeyhimi, B. (2003). Recent developments in spunbonding and meltblowing. *Nonwovens Industry*, 34(6), 48-52.
276. Vahedi, T. H., & Pourdeyhimi, B. (2003). Role of baffles on flow fields inside wet-lay mixing tanks and their potential influence on fiber dispersion. *Textile Research Journal*, 73(7), 575-582.
277. Tafreshi, H. V., & Pourdeyhimi, B. (2003). Role of baffles on flow fields inside wet-lay mixing tanks and their potential influence on fiber dispersion. *Textile Research Journal*, 73(7), 575-582.
278. Tafreshi, H. V., Pourdeyhimi, B., Holmes, R., & Shiffler, D. (2003). Simulating and characterizing water flows inside hydroentangling orifices. *Textile Research Journal*, 73(3), 256-262.
279. Tafreshi, H., & Pourdeyhimi, B. (2003). Simulating the flow dynamics in hydroentangling nozzle: Effect of cone angle and nozzle aspect ratio. *Textile Research Journal*, 73(8), 700-704.
280. Tafreshi, H. V., & Pourdeyhimi, B. (2003). Simulating the flow dynamics in hydroentangling nozzles: Effect of cone angle and nozzle aspect ratio. *Textile Research Journal*, 73(8), 700-704.
281. Berkalp, O., Pourdeyhimi, B., & Seyam, A. M. (2003). Texture evolution in hydroentangled nonwovens. *International Nonwovens Journal*, 12(1), 28-35.
282. Berkalp, O. B., Pourdeyhimi, B., Seyam, A., & Holmes, R. (2003). Texture retention after fabric-to-fabric abrasion. *Textile Research Journal*, 73(4), 316-321.
283. Tafreshi, H., & Pourdeyhimi, B. (2003). The effect of nozzle geometry on waterjet breakup at high Reynolds numbers. *Experiments in Fluids*, 35, 364-371.
284. Tafreshi, H. V., & Pourdeyhimi, B. (2003). The effects of nozzle geometry on waterjet breakup at high Reynolds numbers. *Experiments in Fluids*, 35(4), 364-371.
285. Pourdeyhimi, B., Vaidya, N., Shiffler, D., & Acar, M. (2003). The manufacturing of wet-laid hydroentangled glass fiber composites: Preliminary results. *International Nonwovens Journal*, 12(4), 55-59.
286. Pourdeyhimi, B. (2002). Bicomponent fibers and their applications. In 3rd International Conference on Safety & Protective Fabrics conference proceedings: innovative textile and material developments for safety and protection. Roseville (MN): Industrial Fabrics Association International.
287. Pourdeyhimi, B., & Kim, H.S. (2002). Modeling in-plane fluid transport in nonwovens. In Conference proceedings: Joint INDA-TAPPI Conference, INTC 2002, International Nonwovens Technical Conference, September 24-26, 2002, Renaissance Waverly Hotel, Atlanta, Georgia. Atlanta, Ga. : TAPPI.
288. Tafreshi, H., & Pourdeyhimi, B. (2002). Numerical investigation of the waterjets issued by hydroentangling orifice nozzles. In Conference proceedings: Joint INDA-TAPPI Conference, INTC 2002, International Nonwovens Technical Conference, September 24-26, 2002, Renaissance Waverly Hotel, Atlanta, Georgia. Cary, N.C. : INDA, Association of the Nonwoven Fabrics Industry.
289. Berkalp, O., Seyam, A.M., & Pourdeyhimi, B. (2002). Texture evolution in hydroentangled nonwovens. In INTC 2002: International Nonwovens Technical Conference: conference proceedings: September 24-26, 2002, Renaissance Waverly Hotel, Atlanta, Georgia. Atlanta, Ga.: Tappi Press.
290. Begenir, A., Tafreshi, H.V., & Pourdeyhimi, B. (2002). The role of orifice design in hydroentanglement. In Conference proceedings: Joint INDA-TAPPI Conference, INTC 2002, International Nonwovens Technical Conference, September 24-26, 2002, Renaissance Waverly Hotel, Atlanta, Georgia. Cary, N.C.: INDA.
291. Pourdeyhimi, B., & Kohel, L. (2002). Area based strategy for determining web uniformity. *Textile Research Journal*, 72(12), 1065-1072.

292. Kim, H. S., & Pourdeyhimi, B. (2002). Automatic characterization of refractive index profile of fibers by interferometry. *International Nonwovens Journal*, 11(1).
293. Kim, H. S., Pourdeyhimi, B., Abhiraman, A. S., & Desai, P. (2002). Effect of bonding temperature on load-deformation structural changes in point-bonded nonwoven fabrics. *Textile Research Journal*, 72(7), 645-653.
294. King, M., & Pourdeyhimi, B. (2002). Functional textile materials I - medical materials. *Journal of Applied Polymer Science*, 83(3).
295. Konopka, A., Kim, H. S., & Pourdeyhimi, B. (2002). In-plane liquid distribution of nonwoven fabrics: part 1. *International Nonwovens Journal*, 11(4).
296. Pourdeyhimi, B., & Kim, H. S. (2002). Measuring fiber orientation in nonwovens: The Hough transform. *Textile Research Journal*, 72(9), 803-809.
297. Pourdeyhimi, B. (2001). Measurement of fiber orientation in heavy nonwovens. In INTC 2001: International Nonwovens Technical Conference: conference proceedings: September 5-7, 2001, Renaissance Harborplace Hotel, Baltimore, Maryland. Cary, N.C.: INDA.
298. Konopka, A., & Pourdeyhimi, B. (2001). Measurement of in-plane fluid transport in nonwovens. In INTC 2001: International Nonwovens Technical Conference: conference proceedings: September 5-7, 2001, Renaissance Harborplace Hotel, Baltimore, Maryland. Cary, N.C.: INDA.
299. Pourdeyhimi, B. (2001). Nonwovens cooperative research center: Industry university partnership. *Beltwide Cotton Conferences. Proceedings*.
300. Pourdeyhimi, B., & Kim, H.S. (2001). Predicting mechanical properties in point bonded nonwovens. In INTC 2001: International Nonwovens Technical Conference: conference proceedings: September 5-7, 2001, Renaissance Harborplace Hotel, Baltimore, Maryland. Cary, N.C.: INDA.
301. Kim, H. S., Pourdeyhimi, B., Desai, P., & Abhiraman, A. (2001). Anisotropy in mechanical properties of thermally point-bonded nonwovens: Experimental observations. *Textile Research Journal*, 71(11), 965-976.
302. Kim, H. S., Pourdeyhimi, B., Deshpande, A., Abhiraman, A., & Desai, P. (2001). Characterization of structural changes in point-bonded nonwoven fabrics during load-deformation experiments. *Textile Research Journal*, 71(2), 157-164.
303. Latifi, M., Kim, H. S., Pourdeyhimi, B. (2001). Characterizing fabric pilling due to fabric-to-fabric abrasion. *Textile Research Journal*, 71(7), 640-644.
304. Kim, H. S., Deshpande, A., Pourdeyhimi, B., Abhiraman, A. S., & Desai, P. (2001). Characterizing structural changes in point-bonded nonwoven fabrics during load-deformation experiments. *Textile Research Journal*, 71(2), 157-164.
305. Kim, H. S., & Pourdeyhimi, B. (2001). Computational modeling of mechanical performance in thermally point bonded nonwovens. *Journal of Textile and Apparel Technology and Management*, 1(4).
306. Jeddi, A. A., Kim, H. S., & Pourdeyhimi, B. (2001). Marring of automotive clear coats brought about by wipes. *International Nonwovens Journal*, 10(4).
307. Jeddi, A. A., Kim, H. S., & Pourdeyhimi, B. (2001). Measurement of fiber orientation in nonwovens: Optical Fourier transform. *International Nonwovens Journal*, 10(3).
308. Latifi, M., Kim, H. S., & Pourdeyhimi, B. (2001). A note on pilling due to fabric to fabric abrasion. *Textile Research Journal*, 71(7), 640-644.
309. Kim, H. S., & Pourdeyhimi, B. (2001). The role of structure on mechanical properties of point-bonded nonwovens. *International Nonwovens Journal*, 10(2).
310. Casanova, M. F., Hil, D., & Pourdeyhimi, B. (2001). A study on the mass lesion effect of senile plaques. *Journal of Neuroscience Methods*, 110(1-2), 125-133.
311. Pourdeyhimi, B., & Kim, H.S. (2000). Angular nonwoven properties. *Textile Asia*, 31(3), 3-36.
312. Kim, H. S., Pourdeyhimi, B., Abhiraman, A., & Desai, P. (2000). Characterization of structural changes in nonwoven fabrics during load-deformation experiments. *Journal of Textile and Apparel Technology and Management*, 1(2).

313. Kim, H. S., Latifi, M., & Pourdeyhimi, B. (2000). Characterizing fuzz in nonwoven fabrics. *International Nonwovens Journal*, 9(1), 18-22.
314. Huang, L., McMillan, R. A., Apkarian, R. P., Pourdeyhimi, B., Conticello, V. P., & Chaikof, E. L. (2000). Generation of synthetic elastin-mimetic small diameter fibers and fiber networks. *Macromolecules*, 33(8), 2989-2997.
315. Pourdeyhimi, B., & Batra, S.K. (2000). ITMA '99: A teview. *Textile Progress*, 30(1/2).
316. Pourdeyhimi, B., Kim, H.S., & Lee, F. (2000). Scribe corrosion characterized by distance transform. *European Coatings Journal*, (4), 34-42.
317. Kim, H.S., Pourdeyhimi, B., Desai, P., & Abhiraman, A. (2000). Structural reorientation during load-deformation experiments. In INTC2000: book of papers: joint INDA-TAPPI Conference: International Nonwovens Technical Conference: September 26-28, 2000, Hotel Inter-Continental, Dallas, Texas. Atlanta, GA : TAPPI Press.
318. Kim, H. S., & Pourdeyhimi, B. (2000). A note on the effect of fiber diameter, fiber crimp and fiber orientation on pore size and shape in thin webs. *International Nonwovens Journal*, 9(4), 15-19.
319. Pourdeyhimi, B. (1998). Characterizing fiber orientation and diameter variability nonwoven fabrics. In Nonwovens Conference & Trade Fair: proceedings. Atlanta, GA : TAPPI Press.
320. Pourdeyhimi, B., Wang, X., & Lee, F. (1999). Evaluation of scratch and mar resistance in automotive coatings: Nanoscratching by atomic force microscope. *European Coatings Journal*, (3).
321. Pourdeyhimi, B., Wang, X., & Lee, F. (1999). Making scratch resistance visible. *European Coatings Journal*, (4), 100-106.
322. Pourdeyhimi, B., & Dent, R. (1999). Measurement of fiber orientation in nonwovens, letter to the editor. *Textile Research Journal*, 68(4), 307-308.
323. Pourdeyhimi, B., Dent, R., Jerbi, A., & Tanaka, S. (1999). Measurement of fiber orientation in nonwovens, part 5: Real webs. *Textile Research Journal*, 69(3), 185-192.
324. Pourdeyhimi, B., & Dent, R. (1999). A note on the measurement of fiber diameter distribution in nonwovens. *Textile Research Journal*, 69(4), 233-236.
325. Polk, M., Pourdeyhimi, B., Jacob, K., Warner, S., & Grubb, D. (1998). Spider dragline silk. *Journal of the Textile Institute*, 68(9), 687-696.
326. Gandhi, S., Spivak, S. M., & Pourdeyhimi, B. (1998). A study of smoldering conditions in upholstery fabrics using thermal imaging. *Textile Research Journal*, 68(9), 687-696.
327. Pourdeyhimi, B., & Nunn, D. B. (1997). Intrinsic graft failure 19 years post-implantation. *Cardiovascular Surgery*, 5(3), 333-338.
328. Pourdeyhimi, B., Dent, R., & Davis, H. (1997). Measurement of fiber orientation in nonwovens, part 3: Fourier transform. *Textile Research Journal*, 67(2), 143-151.
329. Pourdeyhimi, B., & Dent, R. (1997). Measurement of fiber orientation in nonwovens, part 4: Flow filed analysis. *Textile Research Journal*, 67(3), 181-190.
330. Nunn, D. B., Carter, M. M., & Pourdeyhimi, B. (1996). Dilative characteristics of Microvel and Vasculour-II aortic bifurcation grafts. *Journal of Biomedical Materials Research*, 30(41-46).
331. Pourdeyhimi, B., Ramanathan, R., & Dent, R. (1996). Measurement of fiber orientation in nonwovens, part 1: Simulation. *Textile Research Journal*, 66(11), 713-722.
332. Pourdeyhimi, B., Ramanathan, R., & Dent, R. (1996). Measurement of fiber orientation in nonwovens, part 2: Direct tracking. *Textile Research Journal*, 66(12), 747-753.
333. Na, Y. J., & Pourdeyhimi, B. (1995). Assessing wrinkling using image analysis. *Textile Research Journal*, 65(3), 149-157.
334. Gandhi, S., Spivak, S.M., & Pourdeyhimi, B. (1995). Computer aided infrared imagery for fabric surface temperature fields under simulated cigarette exposure. *Journal of Fire Protection Engineering*, 7(4), 107-123.
335. Pourdeyhimi, B., & Lee, F. (1995). Evaluating cracking using image analysis, part 1: Algorithms, definitions and techniques. *European Coatings Journal*, 11, 804-812.

336. Pourdeyhimi, B., & Ramanathan, R. (1995). Image analysis method for estimating 2-D fiber orientation and fiber length in discontinuous fiber reinforced composites. *Polymers and Polymer Composites*, 3(4), 277-287.
337. Pourdeyhimi, B., Schirokauer, A., Na, Y., & Chappas, W. (1995). A study of the effect of sterilizing radiation on nonwovens: Physical and mechanical properties. *International Nonwovens Journal*, 7(2), 75-81.
338. Pourdeyhimi, B., & Ulcay, Y. (1994). A study of reinforcement selection for PMMA bone cement for surgical implantation. In ESDA 1994 proceedings of the 1994 Engineering Systems Design and Analysis Conference: presented at the Second Biennial European Joint Conference on Engineering Systems Design and Analysis, London, England, July 4-7, 1994. New York: American Society of Mechanical Engineers.
339. Xu, B., & Pourdeyhimi, B. (1994). Characterizing cotton maturity. *Textile Research Journal*, 64(6), 330-335.
340. Pourdeyhimi, B., & Xu, B. (1994). Characterizing pore size in nonwoven fabrics: Shape considerations. *International Nonwovens Journal*, 6(1), 26-30.
341. Pourdeyhimi, B. (1994). Evaluating carpet appearance loss: Color change. *Textile Research Journal*, 64(8), 485-490.
342. Pourdeyhimi, B., Xu, B., & Wehrle, L. (1994). Evaluating carpet appearance loss: Periodicity and tuft placement. *Textile Research Journal*, 64(1), 21-32.
343. Pourdeyhimi, B., Nayernouri, A., & Xu, B. (1994). Evaluating carpet appearance loss: Pile lay orientation and shading. *Textile Research Journal*, 64(3), 130-135.
344. Pourdeyhimi, B., & Nayernouri, A. (1994). Evaluating traffic paint degradation using image analysis. *Journal of Coatings Technology*, 66(834), 51-58.
345. Pourdeyhimi, B., Ramanathan, R., & Javadpour, S. (1994). Introducing a new carpet wear simulator. *Textile Research Journal*, 64(9), 528-533.
346. Pourdeyhimi, B. (1993). Assessing fiber orientation in nonwoven fabrics. *INDA Journal of Nonwovens Research*, 5(3), 29-36.
347. Pourdeyhimi, B., & Xu, B. (1993). Characterizing pile lay in carpets. *Canadian Apparel*, 110(3), 39-48.
348. Pourdeyhimi, B., Sobus, J., & Xu, B. (1993). Evaluating carpet appearance loss: Surface intensity and roughness. *Textile Research Journal*, 63(9), 523-535.
349. Xu, B., Pourdeyhimi, B., & Sobus, J. (1993). Fiber cross sectional analysis using image processing techniques. *Textile Research Journal*, 63(12), 717-730.
350. Pourdeyhimi, B., & Xu, B. (1993). Pore size characterizing in nonwoven fabrics. *INDA Journal of Nonwovens Research*, 5(3), 20-27.
351. Pourdeyhimi, B., & Ulcay, Y. (1992). Characterization of mechanical properties in vascular prostheses: Dilation. In Proceedings of the 1992 Engineering Systems Design and Analysis Conference: presented at the First European Joint Conference on Engineering Systems Design and Analysis, Istanbul, Turkey, June 29-July 3, 1992. (pp. 107-115). New York: American Society of Mechanical Engineers.
352. Pourdeyhimi, B., & Ulcay, Y. (1992). Statistical analysis of tensile strength of Kevlar 149 fibers. In Proceedings of the 1992 Engineering Systems Design and Analysis Conference: presented at the First European Joint Conference on Engineering Systems Design and Analysis, Istanbul, Turkey, June 29-July 3, 1992. (pp. 149-155). New York: American Society of Mechanical Engineers.
353. Pourdeyhimi, B., Sobus, J., Xu, B., & Ulcay, Y. (1992). Evaluating loss of texture definition in carpets using mathematical morphology: Covariance. *Textile Research Journal*, 62(1), 26-39.
354. Pourdeyhimi, B., Xu, B., & Sobus, J. (1992). Evaluation of crimp in fibers using image analysis: Definitions, algorithms and techniques. *Textile Research Journal*, 62(2), 56-67.
355. Pourdeyhimi, B., & Jackson, K.C. (1992). The transition to rational wage arrangements in British cotton weaving industry. *Ars Textrina*, 17, 7-18.

356. Pourdeyhimi, B., Sobus, J., Gerde, J., & Ulcay, Y. (1991). Assessing changes in texture periodicity due to appearance loss in carpets: Gray level co-occurrence analysis. *Textile Research Journal*, 61(10), 557-567.
357. Pourdeyhimi, B., & Xu, B. (1991). Color description and measurement using digital video capture systems. *Ars Textrina*, 15, 109-128.
358. Pourdeyhimi, B., & Xu, B. (1991). Computer-aided weave design: Algorithms for designing double or backed cloths. *Ars Textrina*, 16, 93-103.
359. Pourdeyhimi, B., Ulcay, Y., & Block, I. (1991). Mechanical performance of ultra-high-strength polyethylene fibers. *Composites Engineering*, 1(3), 145-156.
360. Pourdeyhimi, B., Wu, Y., & Spivak, S. M. (1991). Texture and appearance measurement of carpets using image analysis. *Textile Research Journal*, 61(7), 407-419.
361. Pourdeyhimi, B., Wu, Y., Spivak, S. M., & Hollies, N. R. S. (1990). Instrumental techniques to quantify textural and appearance changes in carpet, part III: Colorimetric image analysis. *Textile Research Journal*, 60(11), 673-687.
362. Pourdeyhimi, B., & Feldstein, M. (1990). A study of the effect of manufacturing treatments on the mechanical properties of polyester fibers used in vascular grafts. *Journal of Materials Science Letters*, 9, 1061-1065.
363. Panandiker, R., & Pourdeyhimi, B. (1989). Computer aided woven fabric design: Determination of weave size in twills. *Ars Textrina*, 12, 93-110.
364. Pourdeyhimi, B., & Wagner, H. D. (1989). Elastic and ultimate properties of acrylic bone cement reinforced with ultra-high molecular weight polyethylene fibers. *Journal of Biomedical Materials Research*, 23, 63-80.
365. Pourdeyhimi, B. (1989). Porosity of surgical mesh fabrics: New technology. *Journal of Biomedical Materials Research*, 23, 145-152.
366. Pourdeyhimi, B. (1989). Programming techniques in computer aided woven fabric design. *Journal of the Textile Institute*, 80, 391-401.
367. Pourdeyhimi, B. (1988). Transposed twills: A programming approach. *Ars Textrina*, 9, 43-62.
368. Pourdeyhimi, B. (1987). On the time to failure of biodegradable sutures: A new approach. *Journal of Materials Science Letters*, 6, 1039-1042.
369. Pourdeyhimi, B., & Jackson, K.C. (1987). Technical progress and the evolution of the wage arrangements in the british cotton weaving industry. *Ars Textrina*, 7, 61-74.
370. Pourdeyhimi, B. (1987). Vascular grafts: Textile structures and their performance. *Textile Progress*, 15(3), 1-35.
371. Pourdeyhimi, B. (1987). A critical review of the structural and material properties in vascular grafts. *Journal of Biomaterials Applications*, 2(2), 163-205.
372. Pourdeyhimi, B., Robinson, H., Schwartz, P., & Wagner, H. D. (1986). Fracture toughness of Kevlar 29 reinforced polymethylmethacrylate for surgical implantation. *Annals of Biomedical Engineering*, 14, 277-294.
373. Pourdeyhimi, B., & Wagner, H. D. (1986). On the correlation between the failure of vascular grafts and their structural and material properties: A critical analysis. *Journal of Biomedical Materials Research*, 20, 375-409.
374. Pourdeyhimi, B., Wagner, H. D., & Schwartz, P. (1986). A comparison of the mechanical properties of Kevlar 29 reinforced bone and dental cements. *Journal of Materials Science*, 21, 4468-4474.
375. Pourdeyhimi, B., & Jackson, K.C. (1986). A note on the diffusion of the automatic weaving within the British cotton industry. *Ars Textrina*, 6, 101-118.
376. Pourdeyhimi, B., Chu, C. C., & Welch, L. (1985). Characterization of the morphologic and mechanical properties of surgical mesh fabrics. *Journal of Biomedical Materials Research*, 19, 903-916.
377. Pourdeyhimi, B., Jackson, K.C., & Hepworth, K. (1985). Development of weaving using automatic looms. *Ars Textrina*, 4, 107-205.
378. Pourdeyhimi, B., & Kern, S.E. (1985). Ease of suturing surgical fabrics: A quantitative evaluation. *American Journal of Surgery*, 149, 387-389.

379. Pourdeyhimi, B., & Chu, C.C. (1984). Theoretical determination of porosity and its application to the design of woven grafts. In J. M. Anderson (Ed.), Biomaterials '84: transactions [of the] second World Congress on Biomaterials, 10th annual meeting of The Society for Biomaterials [and the] Sixteenth International Biomaterials Symposium. Volume VII. [S.l.]: The Society.
380. Pourdeyhimi, B., & Chu, C.C. (1984). The effect of load cycling on dimensional stability of surgical vascular grafts. In J. M. Anderson (Ed.), Biomaterials '84: transactions [of the] second World Congress on Biomaterials, 10th annual meeting of The Society for Biomaterials [and the] Sixteenth International Biomaterials Symposium. Volume VII. [S.l.]: The Biomaterials Society.

INTERNATIONAL PRESENTATIONS

1. Fisher, M. B., Warren, P., Davis, Z., Schuchard, K., Anderson, B., Grondin, P., ... Pourdeyhimi, B. (2020). New Approaches to Improve Translation of Fiber-based Scaffold Approaches. Presented at the Cellular and Molecular Bioengineering Conference (CMBE), Rio Mar, Puerto Rico.
2. Schuchard, K., Anderson, B., Grondin, P., Fisher, M.B., Pourdeyhimi, B., Shirwaiker, R. Anisotropic Scaffold Fabrication using High-Throughput 3D-Melt Blowing. Biofabrication 2019. Columbus, OH, October 20-22, 2019.
3. B. Pourdeyhimi, Recent Trends in Nonwovens and Sustainability, RISE, September 2019, Raleigh, NC.
4. B. Pourdeyhimi, Nonwoven Sustainability, Keynote at Nonwoven Research Academy, EDANA, Denckendorf, Germany, October 2019.
5. Schuchard, K., Pourdeyhimi, B., Fisher, M.B., Shirwaiker, R. Investigating Process-Structure Relationships of 3D-MeltBlowing for Tissue Engineering Applications. Institute of Industrial and Systems Engineers Annual Conference. Orlando, FL, May 18-21, 2019.
6. Pourdeyhimi, B., Developments in the Production of High Surface Area Fibers and Nonwovens for Filtration, SPE, Orlando, FL, March 23-27, 2015.
7. E. Demirci, M. Acar, Pourdeyhimi, B., V. Silberschmidt, Numerical Modeling of Mechanical Response of Fibrous Materials under Out-of-Plane Loading, ICCM2016, August 1st-4th, Berkeley, CA, USA
8. Pourdeyhimi, B., Durable Nonwovens, INDEX, Geneva, 2014.
9. Tuin SA, Haslauer CM, Loboa EG (Jan 2016). Translating Textiles to Tissues: Tissue Engineering Using Industry Standard Manufacturing Approaches. Biomedical Engineering Society: Cellular and Molecular Bioengineering 2016 Annual Meeting, New Orleans, LA.
10. Tuin SA, Pourdeyhimi B, Loboa EG (Jan 2015). From Textiles to Tissues: Economical, Scalable, Textile Industry Standard Nonwovens for Tissue Engineering Applications. Biomedical Engineering Society: Cellular and Molecular Bioengineering 2015 Annual Meeting, Saint Thomas, US Virgin Islands.
11. Tuin SA, Pourdeyhimi B, Loboa EG (Oct 2015). Creating Tissues from Textiles: Scalable Novel High Surface Area Gilled Fiber Scaffolds for Tissue Engineering Applications Using Commercially Relevant Nonwoven Manufacturing Approaches. Proceedings of the 17th Annual North Carolina Tissue Engineering and Regenerative Medicine Society Conference, Winston Salem, NC.
12. Pourdeyhimi, B., Printing Conductive Patterns on Fabrics, TechTextil, Atlanta, GA, 2014.
13. Pourdeyhimi, B., Latest Developments in Bonding, CAB conference, INDA, Greenville, SC, 2014.
14. Tuin SA, Pourdeyhimi B, Loboa EG (Oct 2014). Economical, Scalable, Textile Industry Standard Nonwoven Manufacturing for Tissue Engineering. Proceedings of the 16th Annual North Carolina Tissue Engineering and Regenerative Medicine Society Conference, Durham, NC
15. Bodle JC, Tuin SA, Charoenpanich A, McCullen S, Marvel S, Loboa EG (Mar 2014). Functional Tissue Engineering: Mechanobiology of Adipose Derived Stem Cells. Proceedings of the 18th Annual Regenerative Medicine Workshop, Hilton Head Island, SC.
16. Pourdeyhimi, B., B. Maze, Novel Bicomponent Fibers, Man Made Fiber Conference, Dornbirn, Austria, September 2014.
17. Pourdeyhimi, B., The Latest Developments in Nonwovens Media, Textile World Innovation, Atlanta, GA, September 2014.
18. Pourdeyhimi, B., H. Tafreshi, B. Maze, E. Shim, Modeling Filtration, Filtrex, Berlin, Germany, October 2014.

19. Pourdeyhimi, B., H. Tafreshi, B. Maze, Micro and Macro Modeling Filtration in Nonwovens, Filtrex 2013, Soul, Korea, May 2013.
20. Tuin SA, Cunningham DJ, Pfeiler WT, Bernacki SH, Pourdeyhimi B, Lobo EG (Nov 2013). 3-D Computational Modeling of Fluid Flow Over Winged Fibers: Winged Fibers Enhance Shear Stress and RUNX2 Expression in hASC. Proceedings of the Annual Joint Meeting of the Materials Research Society and the Materials Information Society, Raleigh, NC.
21. Tuin SA, Cunningham DJ, Pfeiler WT, Bernacki SH, Pourdeyhimi B, Lobo EG (Oct 2013). 3-D Computational Modeling of Fluid Flow Over Winged Fibers: Winged Fibers Enhance Shear Stress and RUNX2 Expression in hASC. Proceedings of the 15th Annual North Carolina Tissue Engineering and Regenerative Medicine Society Conference, Winston-Salem, NC.
22. Tuin SA, Miller SM, Cunningham DJ, Pfeiler WT, Bernacki SH, Pourdeyhimi B, Lobo EG (Sep 2013). Winged Fiber Scaffolds Enhance hASC Proliferation, Osteogenesis, and Mechanosensitivity. Proceedings of the Annual Biomedical Engineering Society Conference, Seattle, WA.
23. Tuin SA, Miller SM, Ganesh V, Cunningham DJ, Pfeiler WT, Bernacki SH, Pourdeyhimi B, Lobo EG (Apr 2013). Novel High Surface Area Poly(L-lactic Acid) Nonwoven Scaffolds Exposed to Pulsatile Fluid Flow Increase RUNX2 Expression in Human Adipose Derived Stem Cells. Proceedings of the triennial International Engineered Fabrics Conference and Expo, Miami Beach, FL.
24. Tuin SA, Miller SM, Ganesh V, Cunningham DJ, Pfeiler WT, Bernacki SH, Pourdeyhimi B, Lobo EG (Apr 2013). Novel High Surface Area Poly(L-lactic Acid) Nonwoven Scaffolds Exposed to Pulsatile Fluid Flow Increase RUNX2 Expression in Human Adipose Derived Stem Cells. Proceedings of the Annual Association of Textile, Apparel, and Materials Professionals International Conference, Greenville, SC.
25. Williams J, Mohiti-Asli M, Tuin SA, Morgan D, Kannan A, Hluck B, Lobo EG (Jan 2013). Osteochondral Tissue Engineering Using Human Adipose Derived Stem Cells. Proceeding of the 59th Annual Orthopaedic Research Society Conference, San Antonio, TX.
26. Pourdeyhimi, B., Nonwovens with Stretch and Recovery, TechTextil, Frankfurt, Germany, June 2013.
27. Pourdeyhimi, B., Latest Developments in Nonwovens for Filtration, Keynote address, The American Filtration Society, Minnesota, 2013.
28. Pourdeyhimi, B., A New Generation of Micro-Nano Fiber Nonwovens, Nonwovens Research Academy, Gothenburg, Sweden, April 2012.
29. Pourdeyhimi, B., Stretch and Recovery, Stretch Nonwovens, Man Made Fiber Conference, Dornbirn, Austria, September 2012.
30. Pourdeyhimi, B., Durable Nonwovens with Stretch and Recovery, Man Made Fiber Conference, Dornbirn, Austria, September 2012.
31. Tuin SA, Miller SM, Ganesh V, Cunningham DJ, Pfeiler WT, Bernacki SH, Pourdeyhimi B, Lobo EG (Nov 2012). Novel High Surface Area Poly(L-Lactic Acid) Winged Fiber Scaffolds Increase RUNX2 Expression of Human Adipose Derive Stem Cells Exposed to Shear Stress. Proceedings of the Annual Joint Meeting of the Materials Research Society and the Materials Information Society, Raleigh, NC.
32. Lobo EG, Bodle J, Charoenpanich A, Mathieu P, Mohiti-Asli M, Tuin SA, Williams J (Oct 2012). Biomimetic Forces and Scaffolds to Control Human Stem Cell Fate. Proceedings of the 11th Annual Meeting of the New Jersey Symposium on Biomaterials Science, New Brunswick, NJ.
33. Tuin SA, Miller SM, Ganesh V, Cunningham DJ, Pfeiler WT, Bernacki SH, Pourdeyhimi B, Lobo EG (Sep 2012). Pulsatile Fluid Flow Increases RUNX2 Expression in Human Adipose Derived Stem Cells Cultured on Novel Three-Dimensional High Surface Area Poly(L-Lactic Acid) Scaffolds. Proceedings of the 14th Annual North Carolina Tissue Engineering and Regenerative Medicine Society Conference, Raleigh, NC.
34. Pourdeyhimi, B., Stretch and Recovery, Stretch Nonwovens, TechTextil, Atlanta, April 2012.
35. Kilic, A., Shim, E. & Pourdeyhimi, B., Use of Additives to Enhance Electrostatic Charge in Filters, Filtrex, Cologne, Germany, October 2012.
36. Khansari, S., Sinha-Ray, S., Yarin, A., & Pourdeyhimi, B; Green Materials: Strength of Soy Protein Nanofiber Mats, NSF CMMI Engineering Research and Innovation Conference, Northeastern University, 2012.

37. Pourdeyhimi, B., Nanofibers – Competing Technologies, Nanofiber for the 3rd Millennium, Raleigh, NC, 2011
38. Pourdeyhimi, B., High Performance Nonwovens, NET Inc., TAPPI, Atlanta, November 2011
39. S. Sinha-Ray, Y. Zhang, Yarin, A. L., Pourdeyhimi, B.; Solution Blowing: Monolithic, Blended and Core-shell Nanofibers Incorporating Proteins and Resins, and Production of Turbostratic Carbon Nanotubes, MRS Spring Meeting, San Francisco- 2011.
40. S. Sinha-Ray, Y. Zhang, Yarin, A. L., Pourdeyhimi, B.; Preparation of Nano-textured
41. Surfaces Capable of Achieving Cooling Rates of the Order 1 KW/cm² in Spray Cooling;
42. MRS Spring Meeting, San Francisco- 2011.
43. C. M. Haslauer, Pourdeyhimi, B., E. G. Lobo, Islands-in-the-sea Fibers With Interconnected Micropores For Bone Tissue Engineering. Proceedings of the 56th Annual Meeting of the Orthopaedic Research Society. New Orleans, LA, March 2010.
44. Haslauer, C. M., Pourdeyhimi, B., Lobo, E. G., Validation of Nanoporous Hollow Fiber Scaffolds for Bone Tissue Engineering Using hASCs. Proceedings of the 14th Annual Hilton Head Workshop: Regenerative Medicine: Advancing to Next Generation Therapies. Hilton Head, SC, March 2010.
45. Pourdeyhimi, B., High Volume Micro & NanoFiber Production by Fiber Fibrillation, Nanofiber for the 3rd Millennium, Raleigh, NC, 2010.
46. Hassan, M., Khan S., & Pourdeyhimi, B., Nano-Meltblown Fibers for High Efficiency Filters, Nanofiber for the 3rd Millennium, Raleigh, NC, 2010
47. Yarin, A., Pourdeyhimi, B., Sinha-Ray, S., Solution Blowing of Monolithic, Blended And Core-Shell Nanofibers, Nanofiber for the 3rd Millennium, Raleigh, NC, 2010
48. E. Shim, Pourdeyhimi, B., Nano-composite fibers: Incorporation of Inorganic Nano-Particular Additives, Nanofiber for the 3rd Millennium, Raleigh, NC, 2010
49. S. Honarbakhsh, Pourdeyhimi, B., Nano-Fibrous Drug delivery Systems, Nanofiber for the 3rd Millennium, Raleigh, NC, 2010
50. Sahbaee, A., Oxenham, W. & Pourdeyhimi, B. Novel Mechanism For Fabricating Aligned Electrospun Fibers and Converting Them to Nano-Structured Yarn, Nanofiber for the 3rd Millennium, Raleigh, NC, 2010
51. Kilic, A., Shim, E. Yeom, B. & Pourdeyhimi, B., Polypropylene Nanofiber Production Via Melt Electrospinning Method, Nanofiber for the 3rd Millennium, Raleigh, NC, 2010
52. Y. Aykut, S. Khan, Pourdeyhimi, B., Sol-Gel Electrospinning of Ceramic Nanofibers, Nanofiber for the 3rd Millennium, Raleigh, NC, 2010
53. M. A. Tahir, H. V. Tafreshi and Pourdeyhimi, B., Modeling Radiative Heat Transfer in Fibrous Insulation Media, NET Inc., TAPPI, Raleigh, NC, November 2010
54. P. Young, J. Stahl, N. Anantharamaiah and Pourdeyhimi, B., Modifying the Structure and Properties of Flash Spun Webs by Hydroentangling, NET Inc., TAPPI, Raleigh, NC, November 2010
55. E. Shim, L. B. Suragani Venu, N. Anantharamaiah, and Pourdeyhimi, B., Visualization of 3D Structures of Hydroentangled Nonwovens, NET Inc., TAPPI, Raleigh, NC, November 2010
56. N. Anantharamaiah and Pourdeyhimi, B., Elastomeric Durable Nonwovens Through the use of Novel Bicomponent Fibers, NET Inc., TAPPI, Raleigh, NC, November 2010
57. X. Lui, O. Rojas, J. Genzer, and Pourdeyhimi, B., The Generation and Stability of Organic Films on Textile Surfaces, NET Inc., TAPPI, Raleigh, NC, November 2010
58. J. So, Jacob Thelen, S. Zhu, W. Barnes, Pourdeyhimi, B., and M. Dickey, Highly Stretchable Conductive Fibers, NET Inc., TAPPI, Raleigh, NC, November 2010
59. R. Arambakam, S. A., Hosseini, H. V. Tafreshi, and Pourdeyhimi, B., A 2-D Monte Carlo Simulation of Radiative Heat in Fibrous media, NET Inc., TAPPI, Raleigh, NC, November 2010
60. S. Fotovati, H. V. Tafreshi, and Pourdeyhimi, B., Modeling the Role of Fiber Orientation and Fiber Diameter Distribution on Collection Efficiency and Pressure Drop of Fibrous Filters, NET Inc., TAPPI, Raleigh, NC, November 2010
61. S. Davis, and Pourdeyhimi, B., High Performance Coated Nonwovens for Outdoor Structures, NET Inc., TAPPI, Raleigh, NC, November 2010

62. T. Ghosh, S. Cottrell, N. Anantharamaiah, and Pourdeyhimi, B., Durable and Luanderable Antimicrobial Nonwovens, NET Inc., TAPPI, Raleigh, NC, November 2010
- A. Yoem, E. Shim and Pourdeyhimi, B., Filtration Properties of Area-Enhanced Filter Media, TechTextil North America, Los Vegas, April 2009.
63. H. Tafreshi and Pourdeyhimi, B., Modeling Performance of Multi-layer Composite Air Filters, TechTextil North America, Los Vegas, April 2009.
64. S. Jaganathan, H. Tafreshi and Pourdeyhimi, B., Modeling Fluid Interaction in Fibrous Materials, TechTextil North America, Los Vegas, April 2009.
65. N. Anantharamaiah and Pourdeyhimi, B., Durable, High Strength Microfiber Nonwovens, TechTextil North America, Los Vegas, April 2009.
- B. Pourdeyhimi, B. Yoem, Shape Enhanced Fibers for Filtration, Man Made Fiber Conference, Dornbirn, Austria, September 2009.
66. Pourdeyhimi, B., Nonwovens Tutorial, IAFI, San Diego, September 2009.
67. Pourdeyhimi, B., Emerging Nonwovens, INTC 2008, Houston, September 2008.
68. Pourdeyhimi, B., D. Das, Spatial structural variation in nonwovens and its implications for filtration, INTC 2008, Houston, September 2008.
- C. Shim, M. Latifi and Pourdeyhimi, B., 3-Dimensional Analysis of Segmented Pie Bicomponent Nonwovens, INTC 2008, Houston, September 2008.
- A. D. Hanson, M. E. Wall, Pourdeyhimi, B., E. G. Lobo, Effects of oxygen plasma treatment on adipose-derived adult stem cell adherence. Proceedings of the Annual Meeting of the Biomedical Engineering Society, Los Angeles, CA, September 2007.
- B. Pourdeyhimi, B., Future Directions in Nonwovens Technologies, Beltwide Conference, New Orleans, January 2007.
- C. Pourdeyhimi, B., Opportunities for Cotton, Beltwide Conference, Jan 2007, New Orleans.
69. Pourdeyhimi, B., B., Nonwoven Structure Definition, INTC, September 2006.
70. B. Mazé and Pourdeyhimi, B., Nonwoven Structure Simulation and Definition, INTC, September 2006.
71. Pourdeyhimi, B., Role of Thermal Bonding on Performance, INTC, September 2006.
72. H. V. Tafreshi and Pourdeyhimi, B., Role of Hydroentangling on Performance, INTC, September 2006.
73. B. Mazé and Pourdeyhimi, B., Modeling Mechanical Properties of Thermally Bonded Nonwovens, INTC, September 2006.
74. H. V. Tafreshi and Pourdeyhimi, B., Role of Structure on Transport, INTC, September 2006.
75. V. M. Datla, E. Shim and Pourdeyhimi, B., Surface Modification of Fibers & Nonwovens with Melt Additives, INTC, September 2006
76. N. Fedorova and Pourdeyhimi, B., Commercially Feasible Strong Nano Fiber Based Nonwovens, TechTextil, Atlanta, March 2006.
77. S. K. Batra and Pourdeyhimi, B., From Disposable to Durable – Implications, TechTextil, Atlanta, March 2006.
78. S. Verenich and Pourdeyhimi, B., High Strength Durable Coated Fabrics Made From Nonwovens, TechTextil, Atlanta, March 2006.
79. H. V. Tafreshi and Pourdeyhimi, B., Hydroentangling – A Path to Technical Nonwovens, TechTextil, Atlanta, March 2006.
80. N. Fedorova and Pourdeyhimi, B., Islands-in-the-sea Approach As An Ultimate Route For The Production Of Strong Nanofibers and Nanofiber Webs, ACS, Atlanta, March 2006.
81. H. Q. Wang, B. Maze, H. Vahedi Tafreshi and Pourdeyhimi, B., Nanoparticle Filtration by Virtual Nonwoven Media, AFS, May 2006
82. T. H. Kang, C. R. Merritt, B. Karaguzel, J. Wilson, P.D. Franzon, B. Pourdeyhimi, E. Grant and H.T. Nagle, Sensors on Textile Substrates for Home-Based Healthcare Monitoring, Paper and poster presented at IEEE Conference on Distributed Diagnosis in Health Homecare (D2H2), Arlington, VA, USA, April 2-4, (2006) - (received best poster/paper award).
83. Pourdeyhimi, B., N. Fedorova & J. McCulloch, Meltspun Multi-component Processes for Economic Nanofiber Webs, AFS, May 2006.

84. Pourdeyhimi, B., The Influence of the Number of Segments on Performance in Splittable Nonwovens, INTC 2005, Saint Louis, September 18-22, 2005.
85. Pourdeyhimi, B. and R. Chhabra, Modeling: Pitfalls, INTC 2005, Saint Louis, September 18-22, 2005.
86. B. Mazé and Pourdeyhimi, B., 2-D and 3-D Simulations of Nonwovens Structures, INTC 2005, Saint Louis, September 18-22, 2005.
87. H. Tafreshi and Pourdeyhimi, B., Aerosol Filtration, INTC 2005, Saint Louis, September 18-22, 2005.
88. H. Tafreshi, B. Mazé and Pourdeyhimi, B., Modeling Fluid Flow Through Nonwovens, INTC 2005, Saint Louis, September 18-22, 2005.
89. N. Anantharamaiah, H. Tafreshi and Pourdeyhimi, B., Hydroentangling Principles, INTC 2005, Saint Louis, September 18-22, 2005.
90. Pourdeyhimi, B., The Future of Fiber Research & Development, The Fiber Society Fall 2005 Annual Conference, NJ Institute of Technology, October 17-19, 2005.
91. C.R. Merritt, B. Karaguzel, T.-H. Kang, J. Wilson, P.D. Franzon, Pourdeyhimi, B., H.T. Nagle, and E. Grant, Electrical Characterization of Transmission Lines on Nonwoven Textile Substrates, presented at Materials Research Society 2005 Spring Meeting, Symposium H, Paper H4.7, San Francisco, (2005).
92. C.R. Merritt, B. Karaguzel, T.-H. Kang, J. Wilson, P.D. Franzon, Pourdeyhimi, B., H.T. Nagle, and E. Grant, Electrical Characterization of Transmission Lines on Specific Nonwoven Substrates, Poster, In: 2005 Textile Institute World Conference, Raleigh, NC, USA, March 23-25, (2005).
93. Karaguzel, B., Merritt, C. R., Tae-Ho Kang, Wilson, J., Franzon, P., Nagle, H. T., Grant, E., and Pourdeyhimi, B. Using Conductive Inks and Nonwovens for Wearable Computing, In: Proceedings of the 2005 Textile Institute World Conference, Session 1, Paper 15, Raleigh, NC, USA, March 23-25, (2005).
94. Merritt, C., Tae-Ho Kang, Karaguzel, B., Wilson, J., Pourdeyhimi, B., Nagle, T., and Grant, E. Electrical Characterization of Transmission Lines on Nonwoven Substrates, In: MRS 2005 Spring Meeting, Symposium H, Paper H4.7, San Francisco, March 31-April 1, (2005).
95. Pourdeyhimi, B., Electro-Textiles: Challenges and opportunities, IECON 05, Keynote address, 2005.
96. Pourdeyhimi, B., M. Zaveri, Kenaf Core as a Potential Absorbent Core for Composite Wipes, INTC 2004, September 2004, Toronto, Canada.
97. S. Verenich, E. Shim and Pourdeyhimi, B., Enzymatic Treatment of Cotton Fibers, INTC 2004, September 2004, Toronto, Canada.
98. B. Mazé and Pourdeyhimi, B., Nonwoven Simulations: A Path to Realistic Modeling of Structure property relationships, INTC 2004, September 2004, Toronto, Canada.
99. H. Tafreshi and Pourdeyhimi, B., A Study of Hydroentangling Impact Force, INTC 2004, September 2004, Toronto, Canada.
100. H. Tafreshi, B. Mazé and Pourdeyhimi, B., In-plane and Through-plane Liquid Flow Simulations in Nonwoven Glass Fiber Mats, INTC 2004, September 2004, Toronto, Canada.
101. N. Fedorova and Pourdeyhimi, B., Sub-micron spunbonds via bicomponent fiber technology: Materials, Properties and performance issues, INTC 2004, September 2004, Toronto, Canada.
102. Pourdeyhimi, B. and T. Zapletalova, Wipes produced by In-line Splitting of Segmented Pie Spunbonds, INTC 2004, September 2004, Toronto, Canada.
103. N. Vaidya, Pourdeyhimi, B., M. Acar and D. Shiffler, Hydroentangling Wet-laid Fiberglass Mat, INTC 2004, September 2004, Toronto, Canada.
104. Pourdeyhimi, B., H. Tafreshi and B. Mazé and, In-plane Liquid Flow Through Nonwovens, INTC 2004, September 2004, Toronto, Canada.
105. H. Tafreshi and Pourdeyhimi, B., Hydroentangling, INTC 2004, September 2004, Toronto, Canada.
106. Pourdeyhimi, B., Structure-Process-Property Relationship in Hydroentangled Nonwovens, INTC 2003, September 2003, Baltimore, MD.
107. H. Tafreshi and Pourdeyhimi, B., Cavitation in Hydroentangling Orifices, INTC 2003, September 2003, Baltimore, MD.
108. H. Tafreshi, A. Begenir and Pourdeyhimi, B., The Role of Orifice Geometry on Hydroentangling: Experimental Observations, INTC 2003, September 2003, Baltimore, MD.

109. S. Michielsen, Pourdeyhimi, B. and P. Desai, Review of Thermally Point Bonded Nonwovens: Materials, Processes and Properties, INTC 2003, September 2003, Baltimore, MD.
110. Pourdeyhimi, B., Scratch and Mar Brought About by Wipes, INTC 2003, September 2003, Baltimore, MD.
111. H. Tafreshi and Pourdeyhimi, B., Gas-particle Decoupling by Nozzle-induced Aerodynamic Effects, American Filtration and Separation Society 16th Annual Technical Conference, June 17-20 (2003), Reno, Nevada
112. Pourdeyhimi, B. and H. S. Kim, Modeling In-Plane Fluid Transport in Nonwovens, International Nonwovens Technical Conference, September 24-26, 2002, Atlanta, GA.
113. Begenir, A., Tafreshi, H., & Pourdeyhimi, B.; The Role of Orifice Design in Hydroentanglement, International Nonwovens Technical Conference, September 24-26, 2002, Atlanta, GA.
114. H. Tafreshi and Pourdeyhimi, B., Numerical Investigation of the Waterjets Issued by Hydroentangling Orifice Nozzles, INTC Conference, September 24-26, 2002, Atlanta, Georgia.
115. H. Tafreshi and Pourdeyhimi, B., Numerical Simulation of Hydroentangling Orifice Flow, The Fiber Society, October 16-18, 2002, NATICK, MA.
116. Pourdeyhimi, B. and H. S. Kim, Predicting Mechanical Properties in Point Bonded Nonwovens, International Nonwovens Technical Conference, September, 2001, Baltimore, MD.
117. Pourdeyhimi, B., Measurement of Fiber Orientation in Heavy Nonwovens, International Nonwovens Technical Conference, September 2001, Baltimore, MD.
118. Konopka, A., & Pourdeyhimi, B., Measurement of In-Plane Fluid Transport in Nonwovens, International Nonwovens Technical Conference, September, 2001, Baltimore, MD.
119. H. S. Kim, Pourdeyhimi, B., P. Desai and A. Abhiraman, Structural Reorientation during Load-Deformation Experiments, TAPPI/INDA meeting, September, (2000).
120. H. S. Kim, Pourdeyhimi, B., P. Desai and A. Abhiraman, Modeling Mechanical Behavior of Nonwovens, The Fiber Society, Fall, (2000).
121. A. Konopka, and Pourdeyhimi, B., Modeling In-plane Liquid Transport in Nonwovens, The Fiber Society, Fall 2000, (2000).
122. H. S. Kim and Pourdeyhimi, B., Mechanics Based Modeling of Nonwovens, The Fiber Society, Fall 2000, (2000).
123. G. Wypych, F. Lee and Pourdeyhimi, B., Instrument Selection Affects Correlation Of Laboratory And Outdoor Exposures Of Sealants, ACS, 220: 73-PMSE Part 2, (2000).
124. H. S. Kim, V. Sharma, Pourdeyhimi, B., P. Desai and A. Abhiraman, Orthotropic Symmetry in Textile Structures, The Fiber Society, Fall, (1999).
125. Pourdeyhimi, B., Characterizing Fiber Orientation and Diameter Variability Nonwoven Fabrics, TAPPI, March, (1998).
126. Pourdeyhimi, B. and S. Tanaka, Fiber Re-orientation in Nonwoven Structures, The Fiber Society, Mulhouse, France, April 21-23, (1997).
127. S. Tanaka and Pourdeyhimi, B., Determining Fiber Orientation in Nonwoven Structures, The Fiber Society, Mulhouse, France, April 21-23, (1997).
128. Pourdeyhimi, B., S. Javadpoor and R. Ramanathan, Compression and Torsion behavior of carpets, The Fiber Society, Annapolis, Maryland, May 16-18, (1994).
129. Pourdeyhimi, B., Determining Fiber Orientation in Nonwoven Structures, The World Textile Congress, Huddersfield University, Huddersfield, U. K., July 3-6, (1994).
130. Pourdeyhimi, B., Computer Application in Textiles. The Fiber Society, Atlanta, Georgia, November 16-18, (1994).
131. Pourdeyhimi, B. and Xu, B., Pore Size and Fiber Orientation in Nonwoven Fabrics, The Fiber Society, Raleigh, North Carolina, May 10-12, (1993).
132. Pourdeyhimi, B. and R. Ramanathan, Piece-wise Scanning: A New Approach to Image Generation, The Fiber Society, Cornell University, Ithaca, October 10-12, (1993).
133. Pourdeyhimi, B. and Xu, B., Pore Shape in Nonwoven Fabrics, The Fiber Society, Cornell University, Ithaca, October 10-12, (1993).

134. Pourdeyhimi, B., Pore Size and Fiber Orientation in Nonwoven Fabrics, Presented to the Fiber Science Program, Cornell University, Ithaca, New York, Feb. 10-11, (1993).
135. Pourdeyhimi, B., Pore Size and Fiber Orientation in Nonwoven Fabrics, Presented to the Nonwoven Cooperative Research Center, Raleigh, North Carolina, Feb. 17-18, (1993).
136. Pourdeyhimi, B. and Subus, J., Texture Analysis in Carpets, The Fiber Society, Clemson, South Carolina, Nov. 10-12, (1992).
137. Pourdeyhimi, B., Computer Aided Weave Design, The Fiber Society, Clemson, South Carolina, Nov. 10-12, (1992).
138. Pourdeyhimi, B. and Subus, J., Texture Analysis Using Spatial Statistics, The Fiber Society, Clemson, South Carolina, Nov. 10-12, (1992).
139. Jenkins, A. B., & Pourdeyhimi, B., Structural Features Affecting Texture in Carpets, The Fiber Society, Clemson, South Carolina, Nov. 10-12, (1992).
140. Pourdeyhimi, B., Computer Aided Design: Weave Structures I, The Weaving Professional Series, Clemson, South Carolina, Dec. 1-3, (1992).
141. Pourdeyhimi, B., Computer Aided Design: Weave Structures II, The Weaving Professional Series, Clemson, South Carolina, Dec. 1-3, (1992).
142. Pourdeyhimi, B., Sobus, J., Gerde, J., Xu, B., & Chin, W., Texture Analysis Using Neighborhood Texture Matrices and Granulometry, The International Conference on Textile and Fiber Science, Ottawa, Canada, April 6-8, (1991).
143. Pourdeyhimi, B. and Xu, B., Color Description and Measurement Using Digital Video Capture Systems, The International Conference on Textile and Fiber Science, Ottawa, Canada, April 6-8, (1991).
144. Pourdeyhimi, B., Xu, B., and Subus, J., Fiber Analysis and Identification Using Image Analysis, The International Conference on Textile and Fiber Science, Ottawa, Canada, April 6-8, (1991).
145. V. Agarwal, Ulcay, Y., and Pourdeyhimi, B., Elastic Properties of 3D Randomly Distributed Spectra 900 and Kevlar 49 Discontinuous Fiber Reinforced Composites, The International Conference on Textile and Fiber Science, Ottawa, Canada, April 6-8, (1991).
146. Pourdeyhimi, B., Y. Wu, N. R. S. Hollies, M. H. Kish and S. M. Spivak, A Further Exposition on Image Analysis for Quantifying Carpet Appearance. The Fiber Society Conference, Atlanta, Georgia, March 6-8, (1989).
147. Pourdeyhimi, B. and J. Moreland, Dynamic Testing of Vascular Prostheses. The Fiber Society Conference, College Park, Maryland, November 2-4, (1988).
148. Wagner, H. D., and Pourdeyhimi, B., The Mechanical Behavior of Acrylic Surgical Cement Reinforced with High Performance Fibers. Gordon Conference on Composites, Santa Barbara, California, January 12-16, (1987).
149. Wagner, H. D., and Pourdeyhimi, B., Composite Materials for Use in Orthopedic Applications: Fracture Behavior of Acrylic Bone Cement Reinforced With High Toughness Organic Fibers. The 4th International Conference on Composite Structures, Scotland, U. K., July 27-29, (1987).
150. Pourdeyhimi, B. and C. C. Chu, Theoretical Determination of Porosity and Its Application to the Design of Woven Grafts, The Second World Congress on Biomaterials, 10th Annual Meeting of the Society for Biomaterials, Washington, D. C., April 27-May 1, (1984).
151. C. C. Chu and Pourdeyhimi, B., The Effect of Load Cycling on the Dimensional Stability of Surgical Vascular Grafts, The Second World Congress on Biomaterials, 10th Annual Meeting of the Society for Biomaterials, Washington, D. C., April 27-May 1, (1984).

NATIONAL PRESENTATIONS

1. Pourdeyhimi, B., Nonwovens as a Platform Technology, Combination Products, NC Biotechnology Center, April 9, 2009, Durham, NC.
2. S. D. McCullen, P. R. Miller, S. D. Gittard, Pourdeyhimi, B., R. J. Narayan, Lobo, E. G., In situ collagen polymerization of layered cell-seeded electrospun scaffolds. Proceedings of the 11th Annual North Carolina Tissue Engineering and Regenerative Medicine Conference. Winston-Salem, NC, November 2009.

3. C. H. Haslauer, Pourdeyhimi, B., E, G. Loba., Nonwoven Structures with Interconnected Pore Configuration for Bone Tissue Engineering. Proceedings of the 10th Annual North Carolina Tissue Engineering and Regenerative Medicine (NCTERM) Conference, Raleigh, NC, November 2008.
4. S. Talwar, J. Hinestroza, Pourdeyhimi, B. S. A. Khan, Associative polymer facilitated electrospinning of nanofibers: role of viscoelasticity, Society of Rheology meeting, October 2007, Salt Lake City.
5. Pourdeyhimi, B., New Innovations in Engineered Fabrics, Innovations in Medical, Protective and Technical Textiles, AATCC, Cary, NC, February 1-2, 2006.
6. Pourdeyhimi, B., High Performance Nonwovens, Beltwide Conference, Jan 2007, New Orleans.
7. Pourdeyhimi, B., Industry-Government-University Research Partnerships, AURP 2005 Annual Conference, Raleigh, N.C., November 2-4, 2005.
8. Pourdeyhimi, B., Industry-Government-University Research Partnerships, Licensing Executive Society, 2005 Spring Meeting, Raleigh, N.C., May 4-5, 2005.
9. Pourdeyhimi, B., Industry-Government-University Research Partnerships, AURP 2005 Annual Conference, Raleigh, N.C., November 2-4, 2005.
10. Pourdeyhimi, B., Research Center Management, NSF Annual I-UCRC Center Directors Meeting Washington, DC, January 2006.
11. H. Tafreshi, A. Begenir and Pourdeyhimi, B., The Role of Nozzle Design in Characteristics of the Hydroentangling Waterjets, ILASS Americas, 16th Annual Conference on Liquid Atomization and Spray Systems, Monterey, CA, May 2003
12. Pourdeyhimi, B., Bicomponent Fibers and Their Applications, Industrial Fabrics Association, October 2002, Charlotte, NC.
13. Pourdeyhimi, B., New Directions in Nonwovens Technology, American Fiber Manufacturers' Association, October 2002, Greenville, SC.
14. Pourdeyhimi, B., Nonwovens Cooperative Research Center: Industry University Partnership, Beltwide Conference, Jan 2001, Anaheim, California.
15. Pourdeyhimi, B., Hygiene Issues in Disposable Fabrics, The Industrial Fabrics Meeting, Atlanta, October 21-23, (1996).
16. Pourdeyhimi, B., Application of Image Analysis to Nonwovens, The Textile Research Institute Annual Meeting, Princeton, New Jersey, May 3-6, (1994).
17. Pourdeyhimi, B., Fiber Orientation in Nonwoven Fabrics, Presented to the Nonwoven Cooperative Research Center, Raleigh, North Carolina, Nov. 17-18, (1993).
18. Casanova, M. F, D. Weinberger, E. F. Torrey, Xu, B., Pourdeyhimi, B., Focal temporal lobe abnormalities in schizophrenia. New Research Program and Abstracts American Psychiatric Association Annual Meeting, May 4-7, p. 147, (1992).
19. Ulcay, Y., V. Agarwal and Pourdeyhimi, B., The Effect of Chemical Etching on the Fracture Toughness of 3D Randomly Distributed Spectra 900 and Spectra 1000 Discontinuous Fiber Reinforced Composites, ASME Energy- source Technology Conference and Exhibition, Houston, Texas, January 20- 23, (1991).
20. Ulcay, Y., V. Agarwal and Pourdeyhimi, B., Elastic Properties of 3D Randomly Distributed Spectra 900 and Kevlar 49 Discontinuous Fiber Reinforced Composites, ASME Energy-source Technology Conference and Exhibition, Houston, Texas, January 20-23, (1991).
21. Ulcay, Y., I. Block and Pourdeyhimi, B., Improving the Bond Strength of Spectra 900 and Spectra 1000 High Strength Polyethylene Fibers by Chemical Etching, ASME Energy-source Technology Conference and Exhibition, New Orleans, Louisiana, January 14-17, (1990).
22. Pourdeyhimi, B., Ulcay, Y., and Wagner, H. D., , Elastic properties of Acrylic Bone Cements Reinforced with Ultra High Strength Polyethylene Fibers: The Effect of bond Strength, ASME Energy-source Technology Conference and Exhibition, New Orleans, Louisiana, January 14-17, (1990).
23. Pourdeyhimi, B., G. Chiu and J. Moreland, Mechanical Properties of Vascular Prostheses, ASME Annual Winter Conference, San Francisco, California, December 14-18, (1989).

24. Pourdeyhimi, B. and J. Moreland, A New In-Vitro Fatigue Tester for Dynamic Testing of Vascular Prostheses. ASME Pressure Vessels and Piping Conference, Pittsburgh, Pennsylvania, June 19-23, (1988).
25. Pourdeyhimi, B., Ulcay, Y., M. Singer and I. Block, Mechanical Characteristics of Spectra 900 and Spectra 1000 High Strength Polyethylene Fibers, ASME Pressure Vessels and Piping Conference, Pittsburgh, Pennsylvania, June 19-23, (1988).
26. Pourdeyhimi, B. and S. Ding, Causes of Failure in Arterial Prostheses, The 39th Annual Conference of the Society of Engineering in Medicine and Biology, Maryland, September 13-16, (1986).
27. Pourdeyhimi, B., H. Robinson, P. Schwartz and Wagner, H. D., Mechanical Behavior of Random Fiber Kevlar/PMMA Composites: Preliminary Results, 21st Annual Conference of the Israel Institute of Chemical Engineers, Shefayim, Israel, April 16-17, (1985).

REGIONAL PRESENTATIONS

1. Pourdeyhimi, B., Nonwovens as a Platform Technology, Combination Products, NC Biotechnology Center, April 9, 2009, Durham, NC.
2. Pourdeyhimi, B. and Ulcay, Y., Characterization of Mechanical Properties in Vascular Prostheses: Dilation, 1992 Engineering Systems Design and Analysis Conference, Istanbul, Turkey, June 29-July 3, (1992).
3. Ulcay, Y., and Pourdeyhimi, B., A Study on Bonding Properties of Kevlar 149 Fibers for Use in PMMA Bone Cements, 1992 Engineering Systems Design and Analysis Conference, Istanbul, Turkey, June 29-July 3, (1992).
4. Ulcay, Y., and Pourdeyhimi, B., Statistical Analysis of Tensile Strength of Kevlar 149 Fibers, 1992 Engineering Systems Design and Analysis Conference, Istanbul, Turkey, June 29-July 3, (1992).
5. Wagner, H. D., A. Finkels and Pourdeyhimi, B., Recent Results in the Study of Failure in Fiber Reinforced Bone and Dental Cements, The U. K. Israel Bi-national Symposium on Biomaterials, Tel Aviv, Israel, March 17-19, (1986).
6. Pourdeyhimi, B., H. Robinson, P. Schwartz and Wagner, H. D., Mechanical Behavior of Random Fiber Kevlar/PMMA Composites: Preliminary Results, 21st Annual Conference of the Israel Institute of Chemical Engineers, Shefayim, Israel, April 16-17, (1985).
7. Wagner, H. D., A. Finkels and Pourdeyhimi, B., Composite Materials for Use As Bone Cement: Conditions for Improved Mechanical Properties, 3rd Israel Materials Engineering Conference, Haifa, Israel, December 10- 11, (1985).

US PATENTS - 24

1. Pourdeyhimi, B., Method of preparing a composite sheet **US 11,787,152**, issued October 17, 2023.
2. Pourdeyhimi, B., and Maze, B., High strength nonwoven barrier material, **US 11,479,017**, issued October 25, 2022.
3. Heller, M., Carbonell, R.G., Pourdeyhimi, B., Grafted islands-in-the-sea nonwoven for high-capacity ion exchange bioseparation, **US 11,027,243**, issued June 8, 2021.
4. Pourdeyhimi, B. Elastomeric depth filter. **US 10,464,000**, issued November 5, 2019.
5. Pourdeyhimi, B., Lommel, SA, Honarbakhsh, S, Carbonell, R, Guenther, RH. Biodegradable non-woven fabric having plant virus encapsulated actives for drug delivery, **US 8,535,727**, issued September 17, 2018.
6. Pourdeyhimi, B, Corino, A, Fry, J, Fortner, A, Lambert, B. Methods of forming an artificial leather substrate from leather waste and products therefrom. **US 9,822,481** issued November 21, 2017.
7. Lee, MW, Yoon, SG, Yarin AL, Sinha-Ray S, Pourdeyhimi, B. Electrospinning device. **US 9,469,920**, issued October 18, 2016.

8. Pourdeyhimi, B, Chappas, W, Barnes III, HM. Articles containing woven or non- ultra-high surface area macro polymeric fibers. **US 9,284,663**, issued March 15, 2016.
9. Pourdeyhimi, B, Fedorova, NV, Sharp, SR. High strength, durable micro and nano-fiber fabrics produced by fibrillating bicomponent islands in the sea fibers. **US 8,420,556**, issued April 16, 2013.
10. Chappas, W, Pourdeyhimi, B. Composite filter media with high surface area fibers. **US 8,410,006**, issued April 2, 2013.
11. Pourdeyhimi, B, Fedorova, NV, Sharp, SR. Micro and nanofiber nonwoven spunbonded fabric. **US 8,349,232**, issued January 8, 2013.
12. Deaett, MA, Weedon III, WH, Pourdeyhimi, B. Non-woven textile microwave patch antennas and components. **US 8,174,449**, issued May 8, 2012.
13. Anantharamaiah, N, Pourdeyhimi, B. Staple fiber durable nonwoven fabrics. **US 8,148,279**, issued April 3, 2012.
14. Pourdeyhimi, B, Chappas, W. High surface area fiber and textiles made from the same, **US 8,129,019**, issued March 6, 2012.
15. Pourdeyhimi, B. Process of making mixed fibers and nonwoven fabrics. **US 7,981,336**, issued July 19, 2011.
16. Pourdeyhimi, B, Fedorova, NV, Sharp, SR. High strength, durable micro and nano-fiber fabrics produced by fibrillating bicomponent islands in the sea fibers. **US 7,981,226**, issued July 19, 2011.
17. Pourdeyhimi, B, Fedorova, NV, Sharp, SR. Lightweight high-tensile, high-tear strength biocomponent nonwoven fabrics. **US 7,935,645**, issued May 3, 2011.
18. Pourdeyhimi, B., High strength, durable fabrics produced by fibrillating multilobal fibers. **US 7,883,772**, issued February 8, 2011.
19. Nagle, HT, Kang, T-H, Merritt, C, Karaguzel, B, Pourdeyhimi, B, Grant, E. Sensor device for real-time monitoring or relative movement using capacitive fabric sensors. **US 7,712,373**, issued May 11, 2010.
20. Pourdeyhimi, B, Holmes, R., Little, TJ. Fiber-based nano drug delivery systems (nnds). **US 7,491,407**, issued February 17, 2009.
21. Pourdeyhimi, B, Trafreshi, HV, Anantharamaiah, N. System and method for reducing jet streaks in hydroentangled fibers. **US 7,467,446**, issued December 23, 2008.
22. Deaett, MA, Weedon III, WH, Pourdeyhimi, B. Non-woven textile microwave antennas and components. **US 7,463,198**, issued December 9, 2008.
23. Pourdeyhimi, B, Fedorova, NV, Sharp, R. Lightweight high-tensile, high-tear strength bicomponent nonwoven fabrics. **US 7,438,777**, issued October 21, 2008.
24. Pourdeyhimi, B, Tafreshi, HV. Hydroentangling jet strip device defining an orifice. **US 7,303,465**, issued December 4, 2007.
25. Dixon, MD, Lowder, JT, Pourdeyhimi, B, Tafreshi, HV. Composite hydroentangling nozzle strip and method for producing nonwoven fabrics therewith, **US 7,237,308**, issued July 3, 2007.
26. Pourdeyhimi, B, Little TJ. Photoluminescent fibers and fabrics with high luminance and enhanced mechanical properties, **US 7,128,848**, issued October 31, 2006.
27. Pourdeyhimi, B, Little TJ. Three-dimensional deep molded structures with enhanced properties. **US 7,060,344**, issued June 13, 2006.

INTERNATIONAL PATENTS – 50+

Patent Title	Patent No.	Country
1. Method to Minimize or Eliminate Jet Streaks	Pending	Korea
2. Method to Minimize or Eliminate Jet Streaks	Pending	Europe
3. An Improved Composite Filter Media with High Surface Area Fibers	101617072	China
4. High Efficiency Filters with Low Pressure Drop	Pending	Canada

5.	High Efficiency Filters with Low Pressure Drop	Pending	Canada
6.	High Efficiency Filters with Low Pressure Drop	Pending	China
7.	High Efficiency Filters with Low Pressure Drop	Pending	Japan
8.	High Efficiency Filters with Low Pressure Drop	Pending	Japan
9.	High Efficiency Filters with Low Pressure Drop	Pending	Europe
10.	High Efficiency Filters with Low Pressure Drop	Pending	Europe
11.	Composite Filter Media with High Surface Area Fibers	8,410,006	US
12.	High Strength Durable Micro and Nano-Fiber Fabrics Produced by Fibrillating Islands in the Sea Fibers	2006800228 04.50	China
13.	High Strength Durable Micro and Nano-Fiber Fabrics Produced by Fibrillating Islands in the Sea Fibers	EP1907201	Germany
14.	High Strength Durable Micro and Nano-Fiber Fabrics Produced by Fibrillating Islands in the Sea Fibers	EP1907201	Europe
15.	High Strength Durable Micro and Nano-Fiber Fabrics Produced by Fibrillating Islands in the Sea Fibers	EP1907201	France
16.	High Strength Durable Micro and Nano-Fiber Fabrics Produced by Fibrillating Islands in the Sea Fibers	Pending	Hong Kong
17.	High Strength Durable Micro and Nano-Fiber Fabrics Produced by Fibrillating Islands in the Sea Fibers	EP1907201	Italy
18.	High Strength Durable Micro and Nano-Fiber Fabrics Produced by Fibrillating Islands in the Sea Fibers	5266050	Japan
19.	High Strength Durable Micro and Nano-Fiber Fabrics Produced by Fibrillating Islands in the Sea Fibers	10-1280398	Korea
20.	High Strength Durable Micro and Nano-Fiber Fabrics Produced by Fibrillating Islands in the Sea Fibers	Pending	Mexico
21.	Durable Fabrics Produced by Fibrillating Multilobal Fibers	2,165,010	Europe
22.	Durable Fabrics Produced by Fibrillating Multilobal Fibers	Pending	PCT
23.	Durable Fabrics Produced by Fibrillating Multilobal Fibers	Pending	Hong Kong
24.	High Tensile and High Tear Strength Nonwoven	1866472	Germany
25.	High Tensile and High Tear Strength Nonwoven	1866472	France
26.	High Tensile and High Tear Strength Nonwoven	1866472	UK
27.	Lightweight High-Tensile, High-Tear Strength Bicomponent Nonwoven Fabrics	1866472	Europe
28.	Lightweight High-Tensile, High-Tear Strength Bicomponent Nonwoven Fabrics	Pending	South Korea
29.	Lightweight High-Tensile, High-Tear Strength Bicomponent Nonwoven Fabrics	Pending	Canada
30.	Lightweight High-Tensile, High-Tear Strength Bicomponent Nonwoven Fabrics	5339896	Japan
31.	Hydroentangling Jet Strips Device Defining an Orifice	7,303,465	US
32.	Incorporation of porous silver microparticles in electrospun nanofibers for controlled release scaffolds	Pending	PCT
33.	Method of Forming Nonwovens Utilizing Reduced Energy	Pending	PCT
34.	Microdenier Fibers and Fabrics Incorporating Elastomers or Particulate Additives	Pending	France
35.	Microdenier Fibers and Fabrics Incorporating Elastomers or Particulate Additives	Pending	Germany
36.	Microdenier Fibers and Fabrics Incorporating Elastomers or Particulate Additives	Pending	UK
37.	Mixed Fiber and Nonwoven Fabrics Made from the Same	10-1210973	Korea

38.	Mixed Fiber and Nonwoven Fabrics Made from the Same	ZL20088010	China
		6893.0	
39.	Mixed Fiber and Nonwoven Fabrics Made from the Same	2179081	Germany
40.	Mixed Fiber and Nonwoven Fabrics Made from the Same	2179081	Europe
41.	Mixed Fiber and Nonwoven Fabrics Made from the Same	2179081	France
42.	Mixed Fiber and Nonwoven Fabrics Made from the Same	2179081	UK
43.	Mixed Fiber and Nonwoven Fabrics Made from the Same	2179081	Italy
44.	Mixed Fiber and Nonwoven Fabrics Made from the Same		Japan
45.	Solution Blowing	Pending	PCT
46.	Bicomponent fibers capable of thermally induced shape recovery after low-temperature strain fixing	Pending	PCT
47.	Forming an artificial leather substrate from leather waste	Pending	PCT
48.	Elastomeric Depth Filter	2,800,618	Europe
49.	Three-Dimensional Deep Molded Structures with Enhanced Properties	Pending	Hong Kong
50.	Three-Dimensional Deep Molded Structures with Enhanced Properties	2004236166	Australia
51.	Three-Dimensional Deep Molded Structures with Enhanced Properties	Pending	Brazil

SOFTWARE PACKAGES DEVELOPED – 5

	Year	Citation
1.	1987	Image Processing Software
2.	1988	WEAVE-CAD, Weave Computer Aided Textile Design. Marketed by The University of Maryland.
3.	1991	FAS, Fiber Image Analysis System – Developed for Allied Signal.
4.	1992	IMAGE, Image Analysis System. <i>The software was donated to NC State. Funds generated will go to an educational endowment fund.</i>
5.	1993	PSAS, Paint Surface Analysis System.

APPENDIX B

APPENDIX B
LIST OF MATERIALS CONSIDERED

Document Description	Exhibit No.
U.S. Patent No. 9,308,138 (Andersson)	Exhibit 1001
File History of U.S. Patent No. 9,308,138	Exhibit 1003
International Patent Publication No. WO2009067059A1 (Bergstrom)	Exhibit 1004
U.S. Patent No. 9,066,837 (Kim)	Exhibit 1005
U.S. Patent No. 6,455,753 (Glaug)	Exhibit 1006
U.S. Patent No. 7,956,236 (Ponomarenko)	Exhibit 1007
Japanese Patent Publication Number JP 2008-284190 A (Nakazawa)	Exhibit 1008
C F White, Engineered structures for use in disposable incontinence products, 2003	Exhibit 1009
J.R. Ajmeri and C.J. Ajmeri, Nonwoven personal hygiene materials and products, 2010	Exhibit 1010
Bhupender S. Gupta, Nonwovens in Absorbent Materials, 2002	Exhibit 1011
Kirstin Kosemund et al., Safety evaluation of superabsorbent baby diapers, 2009	Exhibit 1012
Docket Navigator Statistics on Delaware Trials	Exhibit 1013
Essity Hygiene and Health AB, Essity HMS North America Inc. v. First Quality Products, Inc. et al., Case No. 1:24-cv-00374, Complaint for Patent Infringement (D. Del. Mar. 22, 2024)	Exhibit 1014
U.S. Patent No. 7,923,597 (Ponomarenko-597)	Exhibit 1015
U.S. Patent Application Publication No. 2005/0267429A1 (Cohen)	Exhibit 1016
F. Wiesemann and R. Adam, Handbook of Medical Textiles, Chapter 14 - Absorbent products for personal health care and hygiene, 2011	Exhibit 1017
Colin F. White, International Nonwovens Technical Conference, Developments in Absorbent Products and Their Impact on the Nonwovens Industry, 2000	Exhibit 1018
European Patent Specification EP 0701805 B1(Yang)	Exhibit 1019

APPENDIX C

Appendix C (Challenged Claims)

Ground	35 U.S.C. §	Claims	References
I	102 (anticipation)	1, 3, 21-22, and 24-25	Bergstrom-'059
II	103 (obviousness)	1, 3-5, 20- 22, and 24- 25	Nakazawa-'190 + Glaug-'753
III	103 (obviousness)	7	Nakazawa-'190 + Glaug-'753 + Cohen
IV	103 (obviousness)	1-5, 7-8, 21- 22 and 24	Nakazawa-'190 + Ponomarenko-'236
V	102 (anticipation)	1, 3-5, 21- 22, and 24- 25	Nakazawa-'190

Claim No.	Challenged Claim Language	Grounds for Finding Claim Invalid
1[pre]	An absorbent article having a longitudinal direction and a transverse direction, side edges extending in the longitudinal direction and end edges extending in the transverse direction and comprising:	Grounds I-II and IV-V
1[a]	a fluid permeable topsheet,	Grounds I-II and IV-V
1[b]	a fluid impermeable backsheet, and	Grounds I-II and IV-V

Claim No.	Challenged Claim Language	Grounds for Finding Claim Invalid
1[c]	an absorbent core enclosed between said topsheet and said backsheet, said absorbent core comprising,	Grounds I-II and IV-V
1[d]	a first absorbent layer having an opening that passes through the first absorbent layer from one major surface to an opposing major surface and therebetween the opening is surrounded by a closed periphery of first absorbent layer,	Grounds I-II and IV-V
1[e]	a fluid flow control structure, and	Grounds I-II and IV-V
1[f]	a second absorbent layer arranged between the fluid flow control structure and the fluid impermeable backsheet,	Grounds I-II and IV-V
1[g]	wherein the fluid flow control structure is arranged between said first absorbent layer and said backsheet, said fluid flow control structure being a layered structure comprising a non-perforated fibrous polymeric layer and a first perforated polymeric layer, and	Grounds I-II and IV-V
1[h]	wherein the opening extends along a longitudinal center line of the absorbent article, the longitudinal center line being in parallel with the longitudinal direction of the absorbent article, and the fluid permeable top sheet is in direct contact with the fluid flow control structure via the opening.	Grounds I-II and IV-V
2	The absorbent article according to claim 1, wherein the first perforated polymeric	Ground IV

Claim No.	Challenged Claim Language	Grounds for Finding Claim Invalid
	layer has a basis weight of from 60 g/m ² to 100 g/m ² .	
3	The absorbent article according to claim 1, wherein the first perforated polymeric layer is a nonwoven, a film or a film/nonwoven laminate.	Grounds I-II and IV-V
4	The absorbent article according to claim 1, wherein the first perforated polymeric layer is a three-dimensionally formed layer having penetrating apertures extending from a first surface of the first perforated polymeric layer towards a second surface of the first perforated polymeric layer and forming protrusions on said second surface.	Grounds II, IV and V
5	The absorbent article according to claim 4, wherein the first perforated polymeric layer is arranged with said second surface facing the non-perforated fibrous polymeric layer.	Grounds II, IV and V
7	The absorbent article according to claim 4, wherein the average size of the apertures in the first perforated polymeric layer is 0.5-5 mm.	Grounds III and IV
8	The absorbent article according to claim 1, wherein open areas of the first perforated polymeric layer comprise 5-30% of the first perforated polymeric layer.	Ground IV
20	“The absorbent article according to claim 1, wherein the basis weight of the non-	Ground II

Claim No.	Challenged Claim Language	Grounds for Finding Claim Invalid
	perforated fibrous polymeric layer is from 20-120 gsm.”	
21	The absorbent article according to claim 1, wherein the opening extends through an entire crotch portion of the absorbent article.	Grounds I-II and IV-V
22	The absorbent article according to claim 1, wherein the fluid permeable topsheet is not perforated.	Grounds I-II and IV-V
24	The absorbent article according to claim 1, wherein the fluid permeable top sheet is in contact with the first absorbent layer of the absorbent core at an area other than where the opening is located.	Grounds I-II and IV-V
25	The absorbent article according to claim 1, wherein the fluid permeable top sheet is in contact with the fluid flow control structure via the opening, such that a cavity is formed along the longitudinal center line of the absorbent article.	Grounds I-II and V