

Filed on behalf of: Kolon Industries, Inc.

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

HS HYOSUNG ADVANCED MATERIALS CORP.,
Petitioner,
v.

KOLON INDUSTRIES, INC.,
Patent Owner.

Case IPR2025-00663
Patent 10,196,765

**DECLARATION OF DR. DAVID BROOKSTEIN
IN SUPPORT OF PATENT OWNER'S PRELIMINARY RESPONSE**

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I. Introduction and Background

1. I have been retained as an expert witness by Kolon Industries, Inc. (“Kolon”) to provide my analysis and conclusions on certain technical aspects of this dispute. I understand Kolon is the Patent Owner and that HS Hyosung Advanced Materials Corp. (“Hyosung”) is the Petitioner in this case. I understand that Petitioner has challenged the patentability of claims 1-6 (the “Challenged Claims”) of U.S. Patent No. 10,196,765 (Ex.1001) (the “’765 patent”).

2. I am being compensated for my work at my standard consulting rate. My compensation does not depend on the outcome of this proceeding.

3. I have been asked to provide my opinions as to whether the Challenged Claims are patentable. My opinions are set forth in this Declaration.

II. Qualifications

4. I am both a mechanical engineer and a textile engineer with substantial experience in the field of textile and fibrous materials, including in the field of high strength yarns and cords. In forming the opinions expressed in this Declaration, I have considered and relied upon my education, background, and experience. My experience, qualifications, and education are detailed in my *curriculum vitae* (“CV”), a copy of which is attached as Exhibit 2018. My CV also lists my relevant textile patents and identifies parties on behalf of whom I have previously provided expert testimony.

5. I received a Bachelor of Textile Engineering from the Georgia Institute of Technology (“Georgia Tech”) in 1971, a Master of Science degree in Textile Technology from the Massachusetts Institute of Technology (“MIT”) in 1973, and a Doctor of Science degree in the field of Mechanical Engineering from MIT in 1976, with Minor Studies in Management from Sloan School of Management. My doctoral research involved yarn mechanics and manufacturing, which have direct relevance to the subject matter of the ’765 patent.

6. In 1975, I accepted a position as an Assistant Professor of Textile Engineering at Georgia Tech. I taught and conducted research in the fields of textile engineering and composites engineering. One of the textbooks I used in teaching was “Textile Yarns – Technology, Structure, and Applications,” the relevant chapters of which are attached in Exhibit 2020. I obtained substantial funding from the U.S. Department of Energy during my time at Georgia Tech.

7. In 1981, I accepted a part-time position as an Adjunct Professor in Mechanical Engineering at Northeastern University in Boston. I taught undergraduate courses in statics, dynamics, and mechanics of deformable bodies and material science. I was also an Adjunct Professor during my full-time employment at Albany International Research Co. (formerly Fabric Research Laboratories). *See ¶8.*

8. From 1980 to 1994, I was employed by Albany International Research Co. (formerly Fabric Research Laboratories). I started as a Senior Research Associate, was promoted to Assistant Director in 1983, and was again promoted to Associate Director in 1992. In these positions, I directed all activities of the professional engineering group responsible for contract research, development, and manufacture of advanced composite materials and technical polymeric materials of yarns and fabrics. My textile engineering innovations during this time led to 13 U.S. patents and many other unpatented trade secrets.

9. In 1994, I accepted a position with Philadelphia University (formerly Philadelphia College of Textiles and Sciences). From 1994 to 2010, I was the Dean and Professor of Mechanical Engineering at the School of Engineering and Textiles. From 2010 to 2012, I was the Executive Dean for University Research and Professor of Mechanical Engineering. During my time at Philadelphia University, I held many other positions, including Executive Director of the Institute for Textile and Apparel Product Safety, Executive Director of Pennsylvania Advanced Textile Research and Innovation Center including Biomedical Textile Structures Laboratory, and Executive Director of Research. I was also a Principal Investigator for 8 years on a Department of Defense funded project focused on working with the US Army to develop new garment-based soldier protection systems.

10. From 2002 to 2003, I was a Visiting Scholar at Harvard University Center for Textile and Apparel Research (Division of Engineering and Applied Sciences and Harvard Business School). During this time, I studied trends in patent applications involving textile structures.

11. From 2009 to 2012, I also worked as a part-time consultant at MAG Industrial Automation Systems, where I was an engineering consultant to a worldwide manufacturer of engineered automation systems for the aerospace industry.

12. In 2012, I accepted a position as Dean for Science, Technology, Engineering and Mathematics (STEM) at Montgomery County Community College. In this role, I was Chief Academic Officer for all programs in engineering, physical sciences, biological sciences and computer sciences.

13. In 2013, I accepted a role as Director of Market Development at ICF Mercantile. In this role, I was responsible for technical and market development of antimicrobial, antifungal, and flame-resistant textile fabrics.

14. In 2014, I accepted a role as Professor of Mechanical Engineering and Director of Undergraduate Affairs at the Temple University College of Engineering, and in 2017, I was promoted to Senior Associate Dean for Undergraduate Studies at the Temple College of Engineering. From 2014 to 2024, I was responsible for the senior design capstone courses for all engineering

students and was responsible for engineering program accreditation from the Accreditation Board for Engineering and Technology.

15. In 2024, I retired and became Professor Emeritus of Mechanical Engineering at Temple University College of Engineering, which is my current position.

16. From 2000 to today, I have also owned and operated Brookstein Consulting LLC. In this role, I provide engineering and litigation consulting services in the fields of textiles, mechanical assemblies made from textile materials, garment systems, fibers, yarns, fabrics, and composites.

17. In 1992, I was elected by my peers as a Fellow of The Textile Institute (United Kingdom). In 1993, I was awarded the Techtextil Innovation Prize (Germany). In 1995, I was elected by my peers as a Fellow of the American Society of Mechanical Engineers, which is an honorific awarded to only about 1% of its members. In 1998, I was awarded the ASTM Harold Dewitt Smith Award for textile fiber utilization.

18. I have also been a member of the American Society for Engineering Education, the Institute of Industrial and Systems Engineers, the American Conference of Academic Deans, the Fiber Society, and the Society for Advanced Materials and Processes.

19. I am the named inventor on 13 U.S. patents, all of which relate to structures made using the principles of textile engineering and science. I have also developed numerous trade secret inventions.

20. Based on my education and professional experience, I believe I am an expert in the relevant field of the '765 patent and have been an expert in this field since before the first application for the '765 patent was filed. I am familiar with how a person of ordinary skill in the art ("POSITA") would have understood and used the terminologies found in the '765 patent as of the date of the invention.

III. Summary of Analysis and Conclusions

21. In my opinion, Petitioner and Dr. Rust fail to show that any claim of the '765 patent is unpatentable. In particular, Petitioner and Dr. Rust fail to demonstrate independent claim 1 and all dependent claims are rendered obvious by Nakayasu in view of Fritsch. This Declaration focuses on the deficiencies in Petitioner's and Dr. Rust's analysis for claim 1. I reserve my right to opine on other claims in this or other proceedings. I explain the bases for my opinion in detail in this Declaration.

IV. Summary Of Materials Reviewed And Considered

22. All of the opinions contained in this Declaration are based on the documents I reviewed and my knowledge and professional judgment. In forming the opinions expressed in this Declaration, while drawing on my experience in the

field of hybrid tire cords, I reviewed the following documents as well as the documents cited in this Declaration:

- Petition for *Inter Partes* Review of U.S. Patent No. 10,196,765, and the exhibits to the Petition;
- Ex.2020, Textile Yarns – Technology, Structure, and Applications
- Ex.2021, Kevlar Technical Guide;
- Ex.2022, Mechanical Behavior of PET and PEN;
- Ex.2024, Young's Modulus;
- Ex.2025, Kevlar Aramid Fibers for High Performance Composites;
- Ex.2026, IPR2025-00662 Petition;
- Ex.2027, IPR2025-00662 Ex.1003 Dr. Rust Declaration; and
- Ex.2034, The Pneumatic Tire.

23. My opinions are additionally guided by my appreciation of how a POSITA would have understood the claims of the '765 patent at the time of the alleged invention, which I have been asked to assume is June 29, 2015.

V. Legal Standards

24. I understand that a patent claim is invalid for obviousness if the differences between the claimed invention and the prior art would have been obvious to a POSITA before the filing date of the claimed invention.

25. I understand that determining whether a prior art renders a patent claim invalid as obvious is a two-step process. First, the claims must be properly construed. Second, the properly construed claim is compared against the prior art to determine whether a POSITA would have found the claimed invention obvious in light of the prior art. I understand that a determination of whether or not a claim would have been obvious requires determining the scope and content of the prior art, ascertaining differences between the prior art and the claims at issues, resolving the level of skill in the pertinent art, and assessing evidence of secondary considerations when such evidence is presented.

26. I understand that in determining the scope of the prior art, there is an analogous art requirement that applies to each reference. That is, a reference qualifies as prior art for an obviousness determination only when it is analogous to the claimed invention. I understand that prior art is analogous if (1) the art is from the same field of endeavor, regardless of the problem address, or (2) when the reference is not within the field of the inventor's endeavor, the reference still is reasonably pertinent to the particular problem with which the inventor is involved.

27. I further understand that a claim involving multiple components is not proved obvious just by demonstrating that each element was independently known in the art. Even when all elements were independently known in the art at the time of invention, the obviousness inquiry must still determine whether one of ordinary

skill in the art would have had a reason to combine the known elements as expressed in the claim and have had a reasonable expectation of success in doing so.

28. Although I understand that evidence of motivation to combine in the prior art is not required, I understand that it is still important to identify a reason that would have prompted a POSITA to combine the elements as the invention does.

29. I understand that a prior art reference teaches away from the claimed invention if one of ordinary skill in the art, upon reading the reference, would have been led in a different direction from the path taken by the invention. I further understand that each prior art reference may teach away to different degrees, and thus each reference must be examined for what it in fact teaches. I understand that if a POSITA would not have believed at the time of the invention that a particular combination of prior art references would have had a reasonable expectation of success, such a combination may not be obvious.

30. I understand that, because the obviousness determination is based on the knowledge of one of ordinary skill in the art at the time of the invention, it is impermissible to use the benefit of hindsight or to rely on the teachings of the claimed invention to determine whether a POSITA would have found the invention obvious.

VI. Brief Technical Background

31. Since the invention of automobiles, these vehicles have required reinforced rubber tires with specific physical properties to allow for operating the vehicle. Just as the automobile industry has advanced significantly since its inception, so too has the tire industry and the industry for reinforcements of rubber for tires.

32. One of the main components that provides the tire with the appropriate strength, stability, and durability is the tire cord. Tire cords make up the cap ply of the tire, which is a layer of rubberized cords that is wrapped circumferentially under the tread of the tire. The physical restriction of the cap ply causes the movement of the belt edge to be significantly reduced and has three very important and significant consequences. First, the physical restriction reduces stresses and fatigue and loss of properties in the rubber surrounding the belt edges. Second, it reduces the growth of microscopic separations that can develop into larger separations. Third, it reduces tire temperatures—elevated temperatures weaken rubber through a process known as ageing. As a result, tires with cap plies are more durable, less likely to fail from belt separations, and therefore safer and create a more comfortable driving experience than tires without cap plies.

33. Improved vehicle performance and road conditions have brought about gradually increasing vehicle driving speed. As a result, tires with cap plies

before the invention of the '765 patent experienced problems, including, for example, with durability of the tires.

34. As the '765 patent explains, “[r]ecently, improved highway conditions have resulted in increased vehicle speeds, causing problems such as deformation of the belt of the tire and deterioration in drive comfort. For this reason, importance of a cap ply to prevent deformation of the belt is increasing.” Ex.1001, 1:42-47.

35. Conventional tire cords were originally made with a single yarn material, such as nylon or rayon. In an attempt to utilize beneficial properties of multiple materials, tire cord manufacturers attempted to combine single yarn materials together into hybrid tire cords. Hybrid cords consist of at least two different yarn types.

36. Figure 6.11 of “Textile Yarns – Technology, Structure, and Applications” (below) shows the expected behavior of yarns at different twist levels (designated by α , which is the helix angle). A POSITA would have known that helix angle is the angle between the fibers and the longitudinal axis of the yarn or cord.

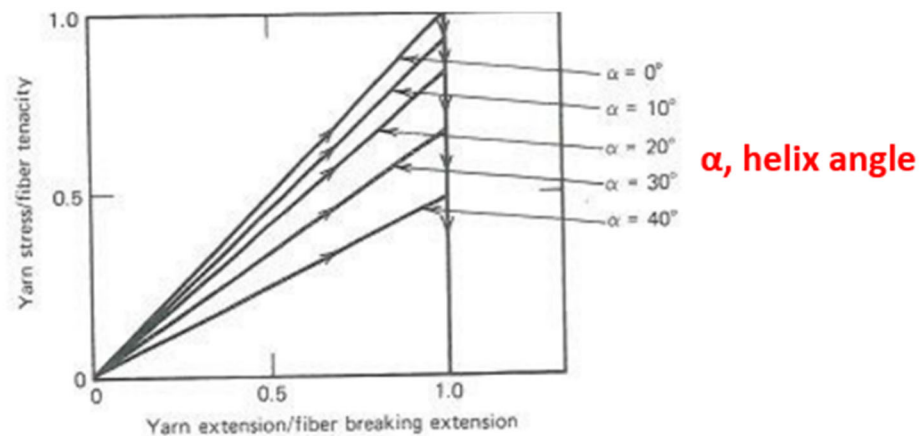
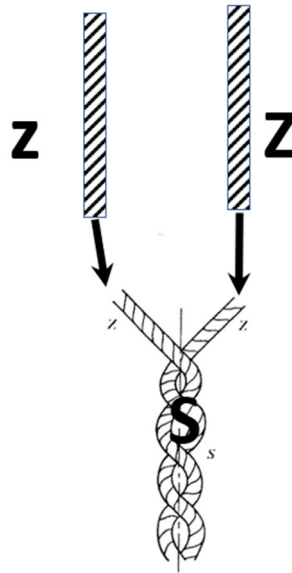


Figure 6.11. Expected behavior of yarns with catastrophic rupture.

Ex.2020 (Textile Yarns – Technology, Structure, and Applications), 62 (annotated). Thus, the tensile strength of a twisted assembly decreases as the amount of twist is increased. Stated another way, the inherent tensile strength of the fibers is not fully realized for a twisted assembly when twist is added. Accordingly, to obtain the full strength of the fibers or filaments, it is common practice to ply two twisted assemblies, both twisted in one direction, in the opposite direction. After this, the “off-axis” individual filaments can be closely aligned along the longitudinal axis of the twisted structure, as shown below:



Ex.2020 (Textile Yarns – Technology, Structure, and Applications), 8 (annotated).

The method described above is the way that plied tire cords have generally been produced.

37. However, prior to the '765 patent's inventions, the structure of 2-ply hybrid tire cords had many drawbacks. The '765 patent explains:

The 2-ply yarn having a covering structure . . . has drawbacks of low production efficiency and high manufacturing cost because it is produced by a three-step process using a ring twister (that is, a first step of primarily twisting an aramid filament yarn to form an aramid primarily twisted yarn, a second step of primarily twisting a nylon filament yarn to form a nylon primarily twisted yarn, and a third step of secondarily twisting the aramid primarily twisted yarn and the nylon primarily twisted yarn).

In addition, there are problems of high deviation in physical properties and increased defect rate in the manufacture of the hybrid

cord, because the aramid primarily twisted yarn for covering the nylon primarily twisted yarn is pulled by friction with a guide or roller to form a roof, or the nylon primarily twisted yarn is compressed, thus causing shape non-uniformity, during drying and thermal treatment after dipping the 2-ply yarn having a covering structure in an adhesive agent solution.

Ex.1001, 2:25-43.

38. The '765 patent also explains that a merge structure was developed to solve the problems of the covering structure described above, by creating a hybrid cord where the nylon and aramid primarily twisted yarns had an identical structure.

Ex.1001, 2:54-63. According to the '765 patent, this merge structure still had drawbacks:

However, in the case of a hybrid cord having a merge structure, stress is intensely applied to the aramid primarily twisted yarn upon repeated tension and compression of tires, thus inevitably causing low fatigue resistance of tire cord and, disadvantageously, resulting in impossibility of securing safety of tires during long-term, high-speed driving.

Ex.1001, 2:64-3:2. The '765 patent aims to solve these and other problems.

VII. The '765 Patent

A. Summary of the '765 Patent

39. The '765 patent, entitled “Hybrid Tire Cord and Method for Manufacturing the Same,” relates to 2-ply aramid and nylon hybrid tire cord.

Ex.1001, Title, Abstract. The '765 patent explains that vehicle performance and road conditions have brought about increased driving speed, which led to a need for tire cords capable of maintaining stability and durability of tires for high-speed driving. Ex.1001, 1:42-47.

40. Tire cords treated with an adhesive agent, referred to as “dip cords,” are widely used as reinforcing materials of rubber products such as tires. One of the essential methods of improving performance of final rubber products is to improve physical properties of tire cords used as reinforcing materials. Ex.1001, 1:26-33.

41. As the '765 patent explains, “[m]ajor materials for currently used tire cords for cap ply are nylon and aramid.” Ex.1001, 1:48-49. “[N]ylon is applied to most tires due to low cost, superior adhesivity and superior fatigue resistance as compared to other materials,” and “nylon has a high compressive stress which is advantageous for preventing deformation of belts during high-speed driving.” Ex.1001, 1:49-53. “However, nylon has a problem of causing flat spots due to low modulus and great deformation with variation in temperature.” Ex.1001, 1:54-56.

42. Aramid, when “used as another material for the cap ply, in addition to the nylon, has almost no flat spot phenomenon in which a tire is deformed upon parking for a long time due to very high modulus and less change in modulus at room temperature and high temperature.” Ex.1001, 1:57-61. Aramid is “generally

for high-quality tire.” Ex.1001, 1:61-62. “However, aramid is inapplicable to general-purpose tires because it is very expensive.” Ex.1001, 1:62-64. “In addition, aramid has drawbacks of relative difficulty in tire molding due to high modulus, and low fatigue resistance and durability due to low breaking elongation.” Ex.1001, 1:64-67.

43. The '765 patent explains that, in view of the problems described above, the inventions of the '765 patent include a 2-ply aramid and nylon hybrid tire cord that can be more efficiently manufactured and is applicable to ultra-high performance tires due to high strength and fatigue resistance with the claimed cord structure below:

In accordance with an aspect of the present invention, the above and other objects can be accomplished by the provision of a hybrid tire cord including a nylon primarily twisted yarn, and an aramid primarily twisted yarn, wherein the nylon primarily twisted yarn and the aramid primarily twisted yarn are secondarily twisted together, and after untwisting (post-untwist) of the secondary twisting of the hybrid tire cord having a predetermined length, a length of the aramid primarily twisted yarn is 1.005 to 1.025 times a length of the nylon primarily twisted yarn.

Ex.1001, 3:12-20, 3:33-43. The claimed 2-ply aramid and nylon hybrid tire cord with the specific length difference range allows the hybrid tire cord to have excellent stability and durability due to its physical properties, while at the same

time being easy to manufacture with low defect rates, solving the problems of the prior art. Independent claim 1 of the '765 patent recites the following:

1. 1[pre] A hybrid tire cord comprising:

1[a] a nylon primarily twisted yarn; and

1[b] an aramid primarily twisted yarn,

1[c] wherein the nylon primarily twisted yarn and the aramid primarily twisted yarn are secondarily twisted together,

1[d] if the secondary twist of the hybrid tire cord with a predetermined length were untwisted, a length of the aramid primarily twisted yarn would be 1.005 to 1.025 times a length of the nylon primarily twisted yarn,

1[e] the aramid primarily twisted yarn has a 0.1 to 5% lower twist number than a twist number of the nylon primarily twisted yarn, and

1[f] the hybrid tire cord has a merge structure having a partial covering structure.

B. Person of Ordinary Skill in the Art

44. Petitioner proposes the following description of a POSA:

A person of ordinary skill in the art ("POSITA") at the time of the '765 patent would have had at least a Bachelor of Science degree in materials science and engineering, textile engineering, chemistry, or an equivalent field, and at least two years of experience with tire reinforcement cord design and manufacture, and/or fiber or polymer science and processing. More education can supplement practical experience and vice versa.

Pet. 12 (citations omitted). For purposes of this Declaration, I have applied Petitioner's definition of a POSITA, but I reserve my right to provide an alternate definition in this or other proceedings. In addition, I note that, while I exceed this level of skill, I am familiar with the qualifications and capabilities of others in the relevant art with this level of skill and am able to provide testimony from the perspective of a POSITA with this level of skill.

C. Claim Construction

45. It is my opinion that Petitioner and Dr. Rust fail to show the prior art references render the subject matter of the Challenged Claims unpatentable under any reasonable construction, including their plain and ordinary meaning.

VIII. Summary of Prior Art References

A. Nakayasu (Ex.1007)

46. Nakayasu, entitled "Pneumatic Radial Tire with Hybrid Band Cord," relates to a pneumatic radial tire with a band belt made of a hybrid cord. Ex.1007, Title, Abstract. Nakayasu discloses that the hybrid cord "includes a low elastic modulus thread and a high elastic modulus thread which are finally-twisted together":

A pneumatic radial tire containing a non-metallic cord breaker belt disposed radially outside a carcass, and a jointless band belt disposed radially outside the breaker belt, said band belt being made of at least one hybrid cord wound spirally and continuously in the circumferential direction of the tire at an angle of 0 to 3 degrees with

respect to the tire equator. The hybrid cord includes a low elastic modulus thread and a high elastic modulus thread which are finally twisted together, said low modulus thread having at least one low modulus fiber, first-twisted and having an elastic modulus of not more than 2000 kgf/sq.mm and said high modulus thread having at least one high modulus fiber first-twisted and having an elastic modulus of not less than 3000 kgf/sq.mm.

Ex.1007, Abstract. Nakayasu further discloses the preferred materials and the elastic moduli of those materials:

The high elastic modulus fiber has an elastic modulus of not less than 3000 kgf/sq.mm, preferably not less than 5000 kgf/sq.mm. Preferably, aramid fiber is used, but polyvinyl alcohol fiber having a strength of not less than 15 g/d [grams per denier], carbon fiber, glass fiber and the like may be used. ...

The low elastic modulus fiber has an elastic modulus of not more than 2000 kgf/sq.mm, preferably not more than 1000 kgf/sq.mm. Preferably, aliphatic polyamide fiber, i.e. nylon fiber is used.

Ex.1007, 5:10-22.

47. Nakayasu includes a Table 1 that shows properties of example tires that use aramid as the high modulus thread and nylon as the low modulus thread:

TABLE 1

Tire No.	1 Ref. A	2 Ref. B	3 Ex. A	4 Ex. B	5 Ex. C	6 Ref. C	7 Ex. D	8 Ref. D	9 Ref. E
Band belt Code No. Material	1	2	3	4	5	6	7	8	9
High modulus thread	aramid 1000D	aramid 1000D	aramid 1000D	aramid 1000D	aramid 1000D	aramid 1000D	aramid 1000D	aramid 1000D	
Low modulus thread	nylon 1260D	nylon 840D	nylon 420D	nylon 420D	nylon 420D	nylon 840D	nylon 420D	nylon 840D	nylon 1260Dx2
<u>First-twist (T/10 cm)</u>									
High modulus thread	42.0	42.0	42.0	42.0	42.0	42.0	30.0	42.0	—
Low modulus thread	24.5	30.0	42.4	20.0	6.0	10.0	6.0	30.0	40.0
Final-twist (T/10 cm)	37.5	42.0	47.8	47.8	47.8	42.0	47.8	42.0	40.0
<u>Stress (kgf)</u>									
F1 at 2% elongation	2.4	1.7	1.1	0.8	0.6	1.2	0.9	1.7	1.3
F2 at 6% elongation	12.0	10.5	8.0	5.9	4.5	5.6	7.6	10.5	3.0
Cord count E (/5 cm)	50	50	50	50	50	50	50	50	50
F1 × E (kgf)	120	85	55	40	30	60	45	85	65
F2 × E (kgf)	600	525	400	295	225	280	380	525	150
Breaker cord material	aramid	aramid	aramid	aramid	aramid	aramid	aramid	steel	aramid
<u>Test results</u>									
Diameter change (mm)	11.4	9.5	6.1	4.5	3.4	6.7	4.9	1.9	7.2
Cut open width (mm)	0.38	0.32	0.30	0.28	0.27	0.29	0.29	0.25	0.31
<u>Crack resistance</u>									
Cracks	occurred	occurred	slight	non	non	slight	non	non	non
Running distance (km)	25,000	25,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000
Steering stability	3.2	3.0	2.9	2.7	2.7	2.8	2.9	3.2	2.5

Ex.1007, Table 1 (annotated). Petitioner and Dr. Rust rely on “Ex. A” in the third column of Nakayasu’s Table 1, which Nakayasu refers to as “hybrid cord 3.” See Pet. 28-29; Ex.1003, ¶¶112-113. Nakayasu discloses the following regarding this example:

The stress-elongation curve 3 is of hybrid cord 3 in Table 1, in which the thickness of the low elastic modulus thread was 420 denier [linear density expressed as grams per 9,000 meters], the first-twist was 42.4 turns/10 cm, and the final-twist was 47.8 turns/10 cm. Accordingly, the apparent difference in the twist number is 5.8 turns/10 cm in the direction of the final-twist of the high elastic modulus thread and 5.4 turns/10 cm in the direction of the final-twist of the low elastic

modulus thread. ... **The tread groove cracks found after 30,000 kilometer running was at less than five positions.**

Ex.1007, 6:20-30 (emphasis added). In comparison, Nakayasu discloses that for “hybrid cord 4,” “[n]o tread groove crack was found even after running for 30,000 kilometers.” Ex.1007, 6:31-38. Similarly, in “hybrid cord 7,” “no crack was found to occur.” Ex.1007, 6:45-49. In other words, hybrid cord 3 was not found to have the best performance based on Nakayasu’s test results.

B. Fritsch (Ex.1023)

48. Fritsch is a published U.S. patent application titled “Hybrid Cabled Cord and a Method to Make It.” Ex.1023, Title. A POSITA would have understood that Fritsch relates to polyethylene naphthalate (“PEN”) and polyethylene terephthalate (“PET”) hybrid cords. Ex.1023, [0009]. A POSITA would have known that PEN and PET are both made from polyester-type polymers. Ex.1023, [0004].

49. Fritsch discloses a specific type of length difference in the components of the hybrid cabled cord, which Fritsch calls the “Coring level,” and discloses non-zero Coring levels of -25% to +25%. Ex.1023, [0029]. Fritsch defines the Coring level as the following:

The phrase “unbalanced configuration” as used herein means that the at least two yarns have different lengths and therefore have a coring level which is not equal to zero[.] The phrase “balanced

configuration” as used herein refers to a yarn having a coring level equal to zero. The difference in lengths is quantitated by determining the coring level. The coring level is measured by taking a sample of one meter of cabled cord and untwisting the cable in order to separate the two yarns which compose it. The so-separated yarns are then untwisted by the same number of turns as it took to separate the cable, and in the opposite direction, to yield the two yarns in their as-fed state. The length of each constituent yarn is then measured on the yarn in its as-fed state, and the coring level calculated using the following equation:

$$\text{Coring} = (A - B)/(B) \quad (1)$$

wherein A is the length of the yarn having the higher modulus and B is the length of the yarn having the lower modulus.

Ex.1023, [0019]-[0020]. Fritsch notes that in one preferred embodiment, the Coring level for a PEN/PET hybrid tire cord is between about 3% to about 15%.

Ex.1023, [0009].

50. Fritsch discloses examples and physical properties **only** for PEN/PET hybrid tire cords. Ex.1023, [0039]-[0042], Table 1, Fig. 2. While Fritsch contemplates aramid and nylon as alternative materials, it does not disclose any examples of aramid and nylon hybrid cord, and does not examine the physical properties of any aramid and nylon hybrid cord at any Coring level, and Dr. Rust does not assert otherwise. *See generally* Ex.1023; Ex.1003, ¶¶79-82.

IX. Grounds 1-2: Petitioner and Dr. Rust fail to show that Nakayasu in view of Fritsch renders obvious claims 1-6

51. In Grounds 1 and 2, Petitioner and Dr. Rust rely on two prior art references, Nakayasu and Fritsch. *See* Pet. 18. But Petitioner's and Dr. Rust's arguments fail because they do not show that a POSITA would have been motivated to combine the teachings of Nakayasu's pneumatic tires made of aramid and nylon hybrid tire cord with the hybrid cord in Fritsch made of different materials, with a reasonable expectation of success, to arrive at the claimed invention. Petitioner and Dr. Rust further fail to show that Fritsch renders obvious the claimed length difference range. In addition, Petitioner and Dr. Rust do not show that Nakayasu renders obvious the claimed twist number difference. Thus, Petitioner and Dr. Rust have not shown that the Challenged Claims are disclosed or rendered obvious by the prior art references.

A. Petitioner and Dr. Rust have not shown a motivation to combine Nakayasu with Fritsch to arrive at the claimed invention nor a reasonable expectation of success for doing so

52. In my opinion, Petitioner and Dr. Rust have failed to show that a POSITA would have combined Nakayasu with Fritsch, with a reasonable expectation of success, to arrive at the claimed invention. Petitioner and Dr. Rust contend that Nakayasu discloses the claim requirements in limitations 1[a]-1[c] of an aramid and a nylon primarily twisted yarn being secondarily twisted together. Pet. 24-25; Ex.1003, ¶¶100-105. Petitioner and Dr. Rust do not contend that

Nakayasu discloses the claim requirement in limitation 1[d] of a length difference between the aramid primarily twisted yarn and nylon primarily twisted yarn if the secondary twist of the hybrid tire cord were untwisted, but argue that Fritsch discloses this limitation. Pet. 25-27; Ex.1003, ¶¶107-111. Petitioner and Dr. Rust contend that “[a] POSITA would have been motivated to combine Nakayasu with Fritsch’s teachings of applying different tension to yarns twisted to form a cord with one yarn being longer than the other.” Pet. 18-19; Ex.1003, ¶85. In addition, Petitioner and Dr. Rust argue that “a POSITA would have been motivated to alter the tension of Nakayasu’s yarn during twisting so that the aramid yarn is 0.9% longer than the nylon yarn, since Fritsch teaches that such a difference provides beneficial improvements to the physical properties of the tire cord.” Pet. 19; Ex.1003, ¶¶85-86.

53. However, a POSITA would have understood that Petitioner and Dr. Rust have failed to support their arguments that a POSITA would have combined Nakayasu and Fritsch with a reasonable expectation of success to arrive at the claimed invention. For example, Petitioner and Dr. Rust do not compare physical properties of a hybrid tire cord disclosed in Nakayasu (i.e., an aramid/nylon hybrid tire cord) with physical properties that a hybrid tire cord of the proposed Nakayasu-Fritsch combination would have possessed to demonstrate any “beneficial improvements” to the physical properties of the tire cord. Pet. 19; Ex.1003, ¶85.

Instead of providing such a comparison, Petitioner and Dr. Rust simply conclude that beneficial improvements would result, without any support. And, as I explain below, Fritsch only examines properties of hybrid tire cord that comprises PEN/PET and alleged improvements for unequal length PEN/PET compared to equal length PEN/PET cords, not aramid/nylon cords. A POSITA would have understood that PEN, PET, aramid, and nylon are all different types of yarns with different physical properties. Any beneficial improvements to the physical properties of a PEN/PET hybrid tire cord would not be obviously applicable to a POSITA considering an aramid/nylon hybrid tire cord. Therefore, a POSITA would not have been motivated to combine Fritsch's teachings to Nakayasu as Petitioner and Dr. Rust assert.

54. For example, in contending that claim limitation 1[e] is met, Petitioner and Dr. Rust rely on Nakayasu's "Ex. A" example in Table 1 as disclosing the claimed "the aramid primarily twisted yarn has a 0.1 to 5% lower twist number than a twist number of the nylon primarily twisted yarn." Pet. 28-29; Ex.1003, ¶¶112-113. As shown below, Nakayasu's Table 1 includes test results of "Ex. A" that show a diameter change of 6.1 mm, a cut open width of 0.30 mm, "slight" cracks, a 30,000 km running distance, and a steering stability of 2.9:

TABLE 1

Tire No.	1 Ref. A	2 Ref. B	3 Ex. A	4 Ex. B	5 Ex. C	6 Ref. C	7 Ex. D	8 Ref. D	9 Ref. E
Band belt Code No. Material	1	2	3	4	5	6	7	8	9
High modulus thread	aramid 1000D	aramid 1000D	aramid 1000D	aramid 1000D	aramid 1000D	aramid 1000D	aramid 1000D	aramid 1000D	
Low modulus thread	nylon 1260D	nylon 840D	nylon 420D	nylon 420D	nylon 420D	nylon 840D	nylon 420D	nylon 840D	nylon 1260Dx2
<u>First-twist (T/10 cm)</u>									
High modulus thread	42.0	42.0	42.0	42.0	42.0	42.0	30.0	42.0	—
Low modulus thread	24.5	30.0	42.4	20.0	6.0	10.0	6.0	30.0	40.0
Final-twist (T/10 cm)	37.5	42.0	47.8	47.8	47.8	42.0	47.8	42.0	40.0
<u>Stress (kgf)</u>									
F1 at 2% elongation	2.4	1.7	1.1	0.8	0.6	1.2	0.9	1.7	1.3
F2 at 6% elongation	12.0	10.5	8.0	5.9	4.5	5.6	7.6	10.5	3.0
Cord count E (/5 cm)	50	50	50	50	50	50	50	50	50
F1 × E (kgf)	120	85	55	40	30	60	45	85	65
F2 × E (kgf)	600	525	400	295	225	280	380	525	150
Breaker cord material	aramid	aramid	aramid	aramid	aramid	aramid	aramid	steel	aramid
<u>Test results</u>									
Diameter change (mm)	11.4	9.5	6.1	4.5	3.4	6.7	4.9	1.9	7.2
Cut open width (mm)	0.38	0.32	0.30	0.28	0.27	0.29	0.29	0.25	0.31
<u>Crack resistance</u>									
Cracks	occurred	occurred	slight	non	non	slight	non	non	non
Running distance (km)	25,000	25,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000
Steering stability	3.2	3.0	2.9	2.7	2.7	2.8	2.9	3.2	2.5

Ex.1007, Table 1 (annotated). Even if a POSITA were to assume that Nakayasu results in a 2-ply aramid and nylon hybrid tire cord where the length of the aramid and nylon primarily twisted yarns are equal, and that once combined with Fritsch, the resulting combination would result in a 0.9% length difference, a POSITA would have not found Petitioner and Dr. Rust to have shown that “such a difference provides beneficial improvements to the physical properties of the tire cords.” Pet. 19. Ex.1003, ¶¶85-86. At the very least, Petitioner and Dr. Rust have failed to provide support that shows the Nakayasu and Fritsch combined Ex. A would have superior properties compared to Nakayasu’s original Ex. A. Instead of providing

any such evidence, Petitioner only alleges, and Dr. Rust repeats, that having a length difference between the yarns leads to “greater tensile strength retention,” (Ex.1003, ¶87) but that statement does not explain how, for example, the results of the testing in Nakayasu would improve. Further, as I explain below, a POSITA would have found that Petitioner and Dr. Rust have not shown that a POSITA would have been motivated to combine Nakayasu with Fritsch to arrive at the claimed invention.

55. Petitioner and Dr. Rust make several arguments for why Fritsch’s disclosures would apply to Nakayasu’s aramid and nylon cord, but none demonstrate why a POSITA would have had a motivation to combine the references.

56. Petitioner and Dr. Rust argue that “Fritsch itself contemplates an aramid/nylon hybrid cord as one of its inventive cords.” Pet. 21 (citing Ex.1023, cls. 8-9); Ex.1003, ¶93 (verbatim). However, Fritsch’s claims 8 and 9 are dependent on Fritsch’s claim 1, and through their dependence on claim 1, only support that the unbalanced configuration can include nylon and aramid yarns. Ex.1023, cls. 8-9. The claims of Fritsch do not recite a specific Coring level for aramid and nylon hybrid cord. And, a POSITA would not have found Fritsch to mention or suggest elsewhere that the 0.9% Coring level applied to PEN/PET cords should be, or even could be, applied to aramid/nylon cords. For example, Fritsch’s

paragraph [0041] only focuses on “*an appropriate coring level of PEN with PET*” (Ex.1023, [0041] (emphasis added)) and Fritsch is silent as to any “appropriate” Coring level of aramid with nylon. Indeed, as I explain below, a POSITA would have understood that because aramid/nylon hybrid cords are made with substantially different materials than PEN/PET hybrid cords (with substantially different elastic moduli ratio), a POSITA would not have used the Coring level for one set of hybrid cords for another, nor would they expect that applying a certain Coring level across hybrid cords made of different materials would lead to the same results, much less translate to the same or similar beneficial results.

57. Dr. Rust does not provide any additional support or evidence of why the Coring level of a PEN/PET hybrid cord would be transferable to the different aramid/nylon hybrid cord. Ex.1003, ¶94. Instead, Dr. Rust appears to simply repeat the assertions in the Petition. But contrary to Petitioner and Dr. Rust’s contentions, as I explain further below, the difference in moduli ratio between aramid and nylon compared to the difference in moduli ratio between PEN and PET is substantial, such that a POSITA would not have understood the properties of a hybrid tire cord with a particular Coring level applied in making PEN/PET hybrid cord to be predictive or render obvious properties of aramid/nylon hybrid cord using that same Coring level. A POSITA also would not have understood that any improved physical properties resulting from using a Coring level for a

PEN/PET cord (e.g., as compared to physical properties for a balanced PEN/PET cord), would exist when using that same Coring level for an aramid/nylon cord. Thus, a POSITA would not have had any reasonable expectation of success that manufacturing aramid/nylon hybrid cord with the Coring level of PEN/PET hybrid cord would achieve good properties.

58. Petitioner and Dr. Rust further assert that “an aramid/nylon hybrid cord uses material with a higher modulus (aramid) and material with a lower modulus (nylon), which is similar to a PEN/PET hybrid cord, as Fritsch describes PEN as having a higher modulus and PET having a lower modulus.” Pet. 21-22; Ex.1003, ¶93 (verbatim). I agree that both PEN/PET hybrid cord and aramid/nylon hybrid cord have materials (yarns) with higher and lower modulus. However, the same is true for virtually *any* hybrid cord made of different materials, because the two materials in any hybrid cord will not necessarily have the same modulus. In other words, Petitioner and Dr. Rust are contending that because Fritsch teaches a 0.9% Coring level for *PEN/PET* cord, then that Coring level would be obvious to apply to *any* hybrid cord, regardless of the materials that the cord is composed of. Neither Petitioner nor Dr. Rust offer any support for such a broad claim. In reality, because the moduli ratio for PEN/PET cord is different than that for aramid/nylon cord, a POSITA would not have had any reason to use the Coring level from the PEN/PET cord for the aramid/nylon cord.

59. Modulus (sometimes referred to as Young's Modulus) of a yarn is the slope of a tensile stress-strain curve at the origin. It is "[t]he property describing a material's resistance to extension." Ex.2021 (Kevlar Technical Guide), 22. "In other words, it is how easily [the material or yarn] is bended or stretched." Ex.2024 (Young's Modulus), 1. Figure 6.2 of "Textile Yarns – Technology, Structure, and Applications" shows a typical stress-strain curve with the slope annotated:

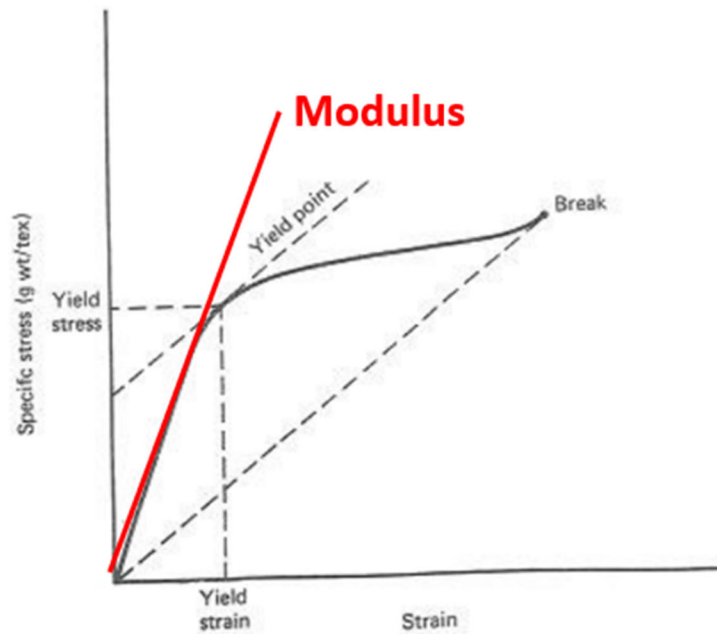


Figure 6.2. Yield point—Meredith's construction.

Ex.2020 (Textile Yarns – Technology, Structure, and Applications), 49 (annotated). The initial part of the stress-strain curve is relatively straight, and its slope (ratio of stress to strain) usually remains constant. Modulus provides a measure of the force required to produce a small extension. A highly inextensible yarn will have a high modulus, and an easily extensible yarn will have a low

modulus. Modulus also sheds light on how a cord will perform as a reinforcement material. Moduli ratio, or the ratio of moduli, as the name suggests, is the ratio of the moduli of two different yarn materials. The moduli ratio reveals how one yarn material will interact with another, and when they are combined into a hybrid cord, the resulting physical properties of the hybrid cord. The most common units for modulus are centinewton per decitex¹ (cN/dtex), pounds per square inch (psi), and Pascals (Pa). Ex.2034 (The Pneumatic Tire), 16 (Table 3.10); Ex.2021 (Kevlar Technical Guide), 22.

60. The moduli of PEN and PET are 130 cN/dtex and 60 cN/dtex, respectively. Ex.2034 (The Pneumatic Tire), 16 (Table 3.10). The moduli ratio of PEN/PET would be 130:60, or around 2:1. In other words, the modulus of PEN is more than twice the modulus of PET. The moduli of aramid and nylon are 300 cN/dtex and 25 cN/dtex, respectively. Ex.2034, 16 (Table 3.10). The moduli ratio for aramid and nylon is 300:25, or 12:1. In other words, the modulus of aramid is twelve times the modulus of nylon. Nakayasu also discloses that in its preferred embodiment, “high elastic modulus fiber has an elastic modulus of ... preferably not less than 5000 kgf/sq.mm ... low elastic modulus fiber has an elastic modulus of ... preferably not more than 1000 kgf/sq.mm.” Ex.1007, 5:10-22. In other

¹ Grams per 10,000 meters of the yarn.

words, the moduli ratio between Nakayasu's high and low elastic modulus fibers is at least 5:1. The moduli and moduli ratios are listed in the table below:

	Modulus	Moduli Ratio
PEN	130 cN/dtex	2:1
PET	60 cN/dtex	
Aramid	300 cN/dtex	12:1
Nylon	25 cN/dtex	
Nakayasu's high modulus fiber	5000 kgf/sq.mm	5:1
Nakayasu's low modulus fiber	1000 kgf/sq.mm	

61. Comparing the 2:1 moduli ratio of PEN/PET with the 5:1 moduli ratio of Nakayasu's preferred embodiment, Nakayasu's moduli ratio is two and a half times higher than the moduli ratio of PEN/PET cords. Further, comparing the 2:1 moduli ratio of PEN/PET with the 12:1 moduli ratio of aramid/nylon, the moduli ratio of aramid/nylon is **six times higher** than that of PEN/PET cord.² A POSITA

² Different references report different moduli of the yarns. One set of references report that the moduli ratio of an aramid/nylon cord is an order of magnitude higher than the moduli ratio of PEN/PET cord, where the moduli of aramid and nylon are 16.3×10^6 psi and 0.8×10^6 psi, respectively (moduli ratio of 20:1), and the moduli of PEN and PET are 26 ± 1 GPa (3.8×10^6 psi) and 13 ± 2 GPa (1.9×10^6 psi), respectively (moduli ratio of 2:1). Ex.2021, 7; Ex.2022 (Mechanical Behavior of

would have been familiar with the difference in moduli ratio between these materials and would have understood that both the 2.5 times difference and the six times difference are significant. Because of these significant differences, a POSITA, if anything, would have only been motivated to apply a Coring level with a larger difference in length between an aramid component and nylon component in aramid/nylon cord as compared to the difference in length between a PEN component and a PET component in PEN/PET cord. And also because of the significant different in moduli ratio, a POSITA would not have found the properties of the PEN/PET hybrid tire cord to be predictive or suggest properties of aramid/nylon hybrid tire cord, because a POSITA would have understood that aramid compared to nylon has much greater resistance or strength than the resistance or strength of PEN compared to PET. Thus, a POSITA would have understood that these hybrid cords with substantially different moduli ratio will have resultant strength and elongation properties that are also substantially and unpredictably different. In my opinion, based at least on these differences, a

PET and PEN), 4. I note that Kevlar 49 is the relevant aramid for hybrid tire cord. Kevlar 49 has a higher modulus and is commonly used in hybrid tire cord for high-performance tires. Ex.2025 (Kevlar® 49 Aramid Fibers for High Performance Composites), 3.

POSITA would not have applied a 0.9% Coring level for PEN/PET hybrid cord to aramid/nylon cord, and also would not have a reasonable expectation of success in arriving at beneficial properties when applying a 0.9% Coring level to aramid/nylon cord.

62. Petitioner and Dr. Rust also contend that “Fritsch expressly teaches that cords using aramid and nylon are ‘[p]olymeric yarns useful in the inventive method and product,’ and expressly states such cords preferably have a coring level between -25% and 25%.” Pet. 22 (quoting Ex.1023, [0029]); Ex.1003, ¶93 (same). Fritsch continues to list over twenty “[n]on-limiting examples” and states that “[p]referred combinations are two yarns having different moduli with a non-zero coring level no greater than about 25% and no less than about -25%,” i.e., a range spanning 50% or more. Ex.1023, [0029]. The claimed range in the ’765 patent, however, is that the aramid yarn is 0.5% to 2.5% longer than the nylon yarn, i.e., a range of only 2%. Ex.1001, cl. 1. In other words, the claimed range is only about 4% of the expansive range disclosed in Fritsch. The ’765 patent explains the benefits of hybrid cords with length difference within the claimed range as the following:

[They] ... exhibit superior uniformity of physical properties, exhibit superior fatigue resistance because stress applied to the hybrid tire cord during repetition of tension/compression of the tire can be dispersed to not only the aramid primarily twisted yarn but also the

nylon primarily twisted yarn, in particular, exhibit superior fatigue resistance when tension/compression deformation is serious, and maintain superior fatigue resistance when tension/compression/shearing is repeatedly applied upon actual tire driving.

Ex.1001, 12:61-13:3. In comparison, the '765 patent explains that cords with a length difference outside of the claimed range result in the aramid yarn being too long compared to the nylon cord, thus leading to “stress [being] intensely applied to the aramid primarily twisted yarn upon repeated tension and compression of the tire.” Ex.1001, 13:4-19. Indeed, the '765 patent contemplates and examines the properties of comparative examples with length differences just slightly outside of the claimed range: one example examined (Comparative Example 4) had no length difference (0% length difference) between the aramid and nylon components, and a second example (Comparative Example 6) had a 3% length difference between the aramid and nylon components. Ex.1001, 13:4-19. Both comparative examples are well within the broad range that Fritsch discloses for its variety of yarns. However, these comparative examples of aramid/nylon cord with length difference that fall within the broad range that Fritsch discloses and that Petitioner and Dr. Rust cite were undesirable. *See* Ex.1001, 13:4-19 (in Comparative Example 4, “characteristics of the tire cord are bad” and Comparative Example 6 “exhibits great deterioration in fatigue resistance strength”). Thus, Petitioner and Dr. Rust

do not provide any reason why a POSITA would have focused on the claimed range of length difference given the broad range disclosed in Fritsch. For this reason, Petitioner's and Dr. Rust's contention that a POSITA would have tried the 0.9% Coring level because "Fritsch provides a finite number of identified, predictable Coring levels" (Pet. 22; Ex.1003, ¶92) is similarly unsupported, because a POSITA would have found that Fritsch instead discloses a wide range of Coring levels.

63. Fritsch, in fact, teaches that a POSITA should proceed in a different direction than the claimed invention. Fritsch discloses that the "preferred" Coring level for PEN/PET is "about 3%³ to about 15%." Ex.1023, Abstract ("In a preferred embodiment one of the two yarns comprises polyethylene terephthalate [i.e., PET] and the second of at least two yarns comprises polyethylene naphthalate [i.e., PEN] and the coring level is between about 3% to about 15%."); [0009]. Similarly, Fritsch also includes claims reciting specific Coring level ranges from 3% to 15% and from -15% to -3%. Ex.1023, cls. 6-7, 26-27. These length difference ranges that Fritsch discloses fall outside of the claimed range. Petitioner and Dr. Rust also do not explain how a POSITA would have adjusted Fritsch's

³ As noted in the previous paragraph, this 3% length difference, applied to an aramid/nylon cord in the '765 patent, had various undesirable characteristics.

ranges for the claimed range of aramid/nylon hybrid cord in view of the moduli ratio of aramid/nylon being six times higher than PEN/PET.

64. A POSITA also would have found that Fritsch discourages using aramid and nylon in its hybrid cord as compared to PEN and PET in the following:

Polyester, Specifically, polyethylene terephthalate (**PET**), **has many advantages over cords made of rayon or polyamide [e.g., aramid or nylon]**. Rayon has good dimensional stability but has low strength, poor durability and is hygroscopic. **Polyamide [e.g., aramid or nylon]** has higher Strength and durability compared to rayon but **has poor dimensional stability**. PET tire cord possesses high strength, good durability, better modulus and low creep. Another polyester, polyethylene naphthalate (**PEN**), **provides even better mechanical properties**, including modulus, breaking strength and elongation, for use in tires than PET.

Ex.1023, [0004] (emphases added). A POSITA would have understood Fritsch's disclosure to mean that polyamide materials such as aramid or nylon are not as good as PEN and PET, and thus a POSITA would not have had reasons to seek a hybrid tire cord made of aramid and nylon, much less apply the length difference for PEN/PET cord to aramid/nylon cord. Indeed, although Fritsch discloses a PEN/PET hybrid cord as having a Coring level of 0.9% in one of its examples (Ex.1023, Table 1 Inv. Ex. 6), Petitioner and Dr. Rust do not offer any evidence or

support that applying Fritsch's teachings would result in property improvements for an aramid/nylon cord.

65. Petitioner and Dr. Rust further argue that “a POSITA would have been motivated to alter the tension of Nakayasu's yarn during twisting so that the aramid yarn is 0.9% longer than the nylon yarn, since Fritsch teaches that such a difference provides beneficial improvements to the physical properties of the tire cord.” Pet. 19; Ex.1003, ¶¶85-86. But Petitioner and Dr. Rust do not show that Nakayasu discloses how its yarns are twisted or that it discloses or suggests that tension adjustments are possible, and thus do not provide any explanation as to **how** Fritsch's teachings would be combined with Nakayasu's.

66. In addition, Petitioner's and Dr. Rust's assertion that applying Fritsch's length difference between the two yarns leads to improved physical properties is directly contrary to their assertion in IPR2025-00662, challenging another patent owned by Patent Owner, that an unbalanced tire cord with a length difference between the two yarns **compromises** tire performance. Specifically, in that proceeding, Petitioner and Dr. Rust assert that “non-uniform (or unbalanced) cord construction” (i.e., cord construction following Fritsch's teachings) “often lead to uneven stress distribution within the tire and composite tire performance ... As a result [of the unbalanced cord construction,] ... the tire performance would be less stable.” Ex.2026 (IPR2025-00662, Petition), 24 (citations omitted);

Ex.2027 (IPR2025-00662, Ex.1003 (Rust Declaration)), ¶77. This is precisely the opposite of what Petitioner and Dr. Rust argue in this IPR.

67. Thus, Petitioner and Dr. Rust have not shown that a POSITA would have been motivated to combine Nakayasu with Fritsch or that a POSITA would have had any motivation and would reasonably succeed in applying Fritsch's 0.9% Coring level to an aramid and nylon hybrid tire cord such that "if the secondary twist of the hybrid tire cord with a predetermined length were untwisted, the aramid primarily twisted yarn would be 1.005 to 1.025 times longer than the nylon primarily twisted yarn."

B. Fritsch does not render obvious a hybrid cord where "if the secondary twist of the hybrid tire cord with a predetermined length were untwisted, a length of the aramid primarily twisted yarn would be 1.005 to 1.025 times a length of the nylon primarily twisted yarn"

68. Similar to the reasons why Petitioner and Dr. Rust fail to show a motivation to combine Nakayasu with Fritsch with a reasonable expectation of success, Petitioner and Dr. Rust also fail to show that Fritsch renders obvious claim limitation 1[d], that "if the secondary twist of the hybrid tire cord with a predetermined length were untwisted, a length of the aramid primarily twisted yarn would be 1.005 to 1.025 times a length of the nylon primarily twisted yarn." Ex.1001, cl. 1[d]. Petitioner and Dr. Rust rely on Fritsch as disclosing or suggesting an aramid/nylon hybrid tire cord with the claimed length difference.

Pet. 25-27; Ex.1003, ¶¶106-111. But Petitioner and Dr. Rust have not shown that Fritsch, alone or in combination with Nakayasu, render obvious the claimed limitation.

69. Petitioner and Dr. Rust contend that the claimed length difference is the equivalent of a Coring level of 0.5% to 2.5% in Fritsch discloses or renders obvious an aramid and nylon hybrid tire cord with “a Coring level of 0.9%.” Pet. 26-27; Ex.1003, ¶¶109-111. Petitioner and Dr. Rust further argue that “a POSITA would have been motivated to combine Fritsch’s teachings with Nakayasu, including the application of a Coring level of 0.9% to Nakayasu’s aramid-nylon hybrid cord.” Pet. 27; Ex.1003, ¶107.

70. However, as I explained in detail above, Fritsch only discloses a 0.9% Coring level for the different materials of PEN and PET, not the claimed aramid and nylon. Petitioner and Dr. Rust rely on Fritsch’s Table 1, Figure 2, and paragraphs [0040]-[0041] as disclosing the 0.9% Coring level. Pet. 26-27; Ex.1003, ¶¶110-111. But each disclosure relates to PEN/PET hybrid cord, not aramid and nylon hybrid cord. Pet. 45-46, 59-60; Ex.1003, ¶¶132-133, 181-183. For example, Fritsch’s paragraph [0041] discloses that “physical properties (breaking strength, elongation at break, energy to break and modulus) can be optimized by *an appropriate coring level of PEN with PET.*” Ex.1023, [0041] (emphasis added). Fritsch’s Table 1 is shown below:

TABLE 1								
Inv. Ex.	Comp. Ex.	Cord components	Coring level	Breaking Strength (N)	Elongation at Break (%)	LASE at 1.6% (N)	LASE at 3% (N)	Elongation (%) at 45 N
1	A	PEN/PEN	0	199.2	10.4	21.4	48.7	2.7
2		PEN/PET	-15%	154	n.d.	n.d.	n.d.	n.d.
3		PEN/PET	-12.2%	154.3	9.3	20.8	45.4	3.1
4		PEN/PET	-9.2%	160.8	10.2	17.5	40.5	3.4
5		PEN/PET	-6.3%	164.7	11.1	16.5	32.8	4.0
6	B	PEN/PET	-3.2%	170.1	11.4	15.7	33.9	3.9
7		PEN/PET	0	180.5	12.4	15	32.7	4.1
8		PEN/PET	0.9%	184	12.8	14.6	33.7	4.1
9		PEN/PET	4.5%	184.5	13.8	13.8	30.8	4.3
10		PEN/PET	7.7%	183.5	15.4	13.2	28.6	4.6
11	C	PEN/PET	13.9%	170.4	16.3	12.8	27.6	4.7
12		PEN/PET	15%	170	n.d.	n.d.	n.d.	n.d.
13		PET/PET	0	177.7	18.9	12.5	26.2	5.2

Ex.1023, Table 1 (annotated). As shown in Fritsch's Table 1, the 0.9% Coring level is associated with "PEN/PET" in "Inv. Ex. 6." Ex.1023, Table 1. Indeed, all examples in Fritsch's Table 1 have cord components of "PEN/PET." Ex.1023, Table 1. Petitioner and Dr. Rust similarly rely on Fritsch's Figure 2 as showing the 0.9% Coring level, but Fritsch's Figure 2 "is a graph of the breaking strength as a function of coring level of the inventive hybrid cabled cords (**Inv. Exs. 1-10**). The data for the balanced hybrid configuration (**Comp. Ex. B**) is also shown for reference." Ex.1023, [0042]. These are examples shown in Fritsch's Table 1. Ex.1023, [0042]. In other words, the examples shown in Fritsch's Figure 2 are also of PEN/PET cords, not of aramid/nylon cords.

71. Petitioner and Dr. Rust only acknowledge that the 0.9% Coring level is not for aramid/nylon cords, but for PEN/PET cords, in their alleged "motivation

to combine” Nakayasu with Fritsch. Pet. 21; Ex.1003, ¶93. But Petitioner and Dr. Rust only contend that a Coring level of 0.9% “provides a good combination of high Breaking Strength, Elongation at Break, LASE at 1.6% and LASE at 3%,” without explaining why a POSITA would have applied this Coring level of PEN/PET cord to cords made of the completely different materials of aramid and nylon. Pet. 21-22; Ex.1003, ¶90. The paragraph in Fritsch that Petitioner and Dr. Rust cite for their contentions, Fritsch’s paragraph [0040], does not even state that Inv. Ex. 6 with the 0.9% Coring level has “good properties.” Pet. 21 (citing Ex.1023, [0040]); Ex.1003, ¶90 (same). To the contrary, Fritsch’s paragraph [0041], discussing the results in Fritsch’s Table 1, only discusses “good” properties for Inv. Exs. 2-5 and 7-8:

Notably the balanced configuration of the PET/PEN hybrid (Comp. Ex. B) had a breaking strength and LASE at 1.6% closer to that of the all-PET balanced configuration (Comp. Ex. C), and had elongation at break value closer to that of the all-PEN configuration (Comp. Ex. A). The inventive hybrid cords, having unbalanced configuration, depending on the degree and sign of the coring, possessed different properties. *Higher modulus hybrid cabled cord can be achieved by the use of negative coring (Inv. Exs. 2-5). For a combination of a high breaking strength and a high elongation at break, a positive coring value is satisfactory (Inv. Exs. 7 and 8).* Thus, physical properties (breaking strength, elongation at break,

energy to break and modulus) can be optimized by an appropriate coring level of PEN with PET.

Ex.1023, [0041] (emphases added). Inventive Example 6 is conspicuously missing from this passage. Thus, a POSITA would not have had reason to apply Fritsch's examples made of PEN and PET to completely different materials, aramid and nylon.

72. Thus, Petitioner and Dr. Rust have not shown under Ground 1 that a POSITA would have been motivated to combine Nakayasu with Fritsch with a reasonable expectation of success, or that the claimed hybrid tire cord is rendered obvious where "if the secondary twist of the hybrid tire cord with a predetermined length were untwisted, the aramid primarily twisted yarn would be 1.005 to 1.025 times longer than the nylon primarily twisted yarn."

C. Nakayasu does not render obvious a hybrid cord where "the aramid primarily twisted yarn has a 0.1 to 5% lower twist number than a twist number of the nylon primarily twisted yarn"

73. Petitioner and Dr. Rust contend that "Nakayasu discloses a tire cord embodiment where its *aramid primarily twisted yarn* has a *0.9% lower twist number* than that of its *nylon primarily twisted yarn*." Pet. 28 (emphases in original); Ex.1003, ¶113 (verbatim). Petitioner and Dr. Rust cite as support portions of Nakayasu's Table 1 and its "Ex. A." Pet. 28-29; Ex.1003, ¶¶112-113. Petitioner's and Dr. Rust's cited portion of Nakayasu's Table 1 is reproduced below:

Tire No.	1 Ref. A	2 Ref. B	3 Ex. A
Band belt Code No. <u>Material</u>	1	2	3
High modulus thread	aramid 1000D	aramid 1000D	aramid 1000D
Low modulus thread	nylon 1260D	nylon 840D	nylon 420D
<u>First-twist (T/10 cm)</u>			
High modulus thread	42.0	42.0	42.0
Low modulus thread	24.5	30.0	42.4
Final-twist (T/10 cm)	37.5	42.0	47.8

Pet. 29; Ex.1003, ¶113 (highlights in original).

74. However, Petitioner and Dr. Rust are ignoring the rest of Nakayasu's Table 1, which is reproduced below again. A POSITA would have understood that Nakayasu's Table 1 shows six other inventive examples that do not meet the claimed twist number difference limitation.

TABLE 1

Tire No.	1 Ref. A	2 Ref. B	3 Ex. A	4 Ex. B	5 Ex. C	6 Ref. C	7 Ex. D	8 Ref. D	9 Ref. E
Band belt Code No.	1	2	3	4	5	6	7	8	9
Material									
High modulus thread	aramid 1000D	aramid 1000D	aramid 1000D	aramid 1000D	aramid 1000D	aramid 1000D	aramid 1000D	aramid 1000D	
Low modulus thread	nylon 1260D	nylon 840D	nylon 420D	nylon 420D	nylon 420D	nylon 840D	nylon 420D	nylon 840D	nylon 1260Dx2
First-twist (T/10 cm)									
High modulus thread	42.0	42.0	42.0	42.0	42.0	42.0	30.0	42.0	—
Low modulus thread	24.5	30.0	42.4	20.0	6.0	10.0	6.0	30.0	40.0
Final-twist (T/10 cm)	37.5	42.0	47.8	47.8	47.8	42.0	47.8	42.0	40.0
Stress (kgf)									
F1 at 2% elongation	2.4	1.7	1.1	0.8	0.6	1.2	0.9	1.7	1.3
F2 at 6% elongation	12.0	10.5	8.0	5.9	4.5	5.6	7.6	10.5	3.0
Cord count E (1/5 cm)	50	50	50	50	50	50	50	50	50
F1 × E (kgf)	120	85	55	40	30	60	45	85	65
F2 × E (kgf)	600	525	400	295	225	280	380	525	150
Breaker cord material	aramid	aramid	aramid	aramid	aramid	aramid	aramid	steel	aramid
Test results									
Diameter change (mm)	11.4	9.5	6.1	4.5	3.4	6.7	4.9	1.9	7.2
Cut open width (mm)	0.38	0.32	0.30	0.28	0.27	0.29	0.29	0.25	0.31
Crack resistance									
Cracks	occurred	occurred	slight	non	non	slight	non	non	non
Running distance (km)	25,000	25,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000
Steering stability	3.2	3.0	2.9	2.7	2.7	2.8	2.9	3.2	2.5

Ex.1007, Table 1 (annotation added).

75. Not only do Petitioner and Dr. Rust ignore the existence of these examples, but these examples would have suggested to a POSITA that the claimed twist number difference was not obvious. In particular, viewing Nakayasu in its entirety, a POSITA would not have been motivated to use the twist number difference as disclosed for “Ex. A.” This is because Nakayasu identifies issues with Ex. A, stating that it experienced groove cracks after running for 30,000 kilometers: “The tread groove cracks found after 30,000 kilometer running was at less than five positions.” Ex.1007, 6:29-30. In comparison, Nakayasu noted that for Ex. B, “[n]o tread groove crack was found even after running for 30,000

kilometers, and for Ex. D, “no crack was found to occur.” Ex.1007, 6:37-38, 6:48-49. In addition, Nakayasu ranks the examples’ “Steering stability,” which is “an evaluation into five ranks made by a driver who run a test car provided with the test tires in a test course.” Ex.1007, 5:62-64. As Nakayasu explains, “[t]he larger the value, the better the stability.” Ex.1007, 5:64-65. A POSITA would have noted that Nakayasu’s Ex. A has a worse stability ranking, a “2.9,” compared to other reference examples such as “Ref. D,” which has a better stability ranking of “3.2” but a much more significant twist number difference that falls outside of the claimed range. Ex.1007, Table 1.

76. Further, a POSITA would have understood that Ex. B shows a 110% higher aramid twist number than nylon twist number, and Ex. D shows a 400% higher aramid twist number than nylon twist number. Ex.1007, Table 1. Given the disadvantages of Nakayasu’s Ex. A that I explained above, a POSITA would not have been motivated to use Ex. A but would have instead been motivated to pursue cords with twist number differences falling outside of the claimed range that have been disclosed with significantly improved performance.

77. Thus, a POSITA would not have found the claimed twist number difference to have been rendered obvious by Nakayasu.

78. In sum, for the reasons explained above, Petitioner and Dr. Rust have not shown that independent claim 1 of the ’765 patent, and all dependent claims,

are rendered obvious. In my opinion, the Challenged Claims of the '765 patent are patentable.

X. CONCLUSION

All statements made herein of my own knowledge are true, and all statements made on information and belief are believed to be true. Further, I am aware that these statements are made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. § 1001. I declare under penalty of perjury that the foregoing is true and correct.

Executed on July 14, 2025 in Fort Washington, Pennsylvania.



David Brookstein