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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

APPLE INC.,

Petitioner,

v.

MASIMO CORPORATION,

Patent Owner.

Case IPR2022-01291, IPR2022-01465
U.S. Patent 10,687,745

DECLARATION OF R. JAMES DUCKWORTH IN SUPPORT OF PATENT OWNER'S RESPONSES

I declare that all statements made herein on 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.

I reserve the right to supplement my opinions in the future to respond to any arguments or positions Apple may raise, taking account of new information as it becomes available to me.

Dated: 5/26/2023

R. James Duckworth, Ph.D.

MASIMO 2121
Apple v. Masimo
IPR2024-00243

I, R. James Duckworth, declare and state as follows:

I. INTRODUCTION

1. My name is R. James Duckworth, Ph.D. I have been retained by Knobbe, Martens, Olson & Bear, LLP, counsel for Patent Owner Masimo Corporation ("Masimo"). I previously submitted two declarations in IPR2022-01291 and IPR2022-01465, both of which concern the '745 Patent. Both declarations are labeled Exhibit 2002 in their respective IPRs. I expressly incorporate by reference my original declarations, EX2002 in IPR2022-01291 and EX2002 in IPR2022-01465, as if set forth fully herein.

2. I am providing this supplemental declaration to provide additional opinions relating to IPR2022-01291 and IPR2022-01465. I may refer to my original declarations throughout this supplemental declaration. I will refer to my original declaration in IPR2022-01291 as EX2002-1291 and to my original declaration in IPR2022-01465 as EX2002-1465.

3. I have continued to apply the legal standards provided to me by counsel as set forth in my original declarations.

II. MATERIALS CONSIDERED

4. In paragraphs 3-6 of Exhibit 2002-1291 and in paragraphs 3-5 of Exhibit 2002-1465, I listed the materials I considered with respect to my original

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declarations. In connection with this declaration, I have considered those materials and further considered the following materials:

Exhibit	Description
2071	Transcript of March 24, 2023 Deposition of Dr. Brian W. Anthony
2072	Excerpt of Webster's II New College Dictionary (2001)
2073	Encyclopedia Britannica, *Light, the visible spectrum*, https://www.britannica.com/science/light (last visited May 19, 2023)
2074	Nonconfidential Excerpt of Page 65 from June 6-10, 2022 Hearing Transcript, *Masimo Corp. et al. v. Apple Inc.*, ITC Inv. No 337-TA-1276
2075	February 13, 2023 Respondent Apple Inc.'s Response to Complainants' Petition for Review (Public Version), filed in *Masimo Corp. et al. v. Apple Inc.*, ITC Inv. No 337-TA-1276
2076	CONFIDENTIAL – Transcript of Testimony of Brian Land from June 6-10, 2022 Hearing Transcript, *Masimo Corp. et al. v. Apple Inc.*, ITC Inv. No 337-TA-1276
2077	CONFIDENTIAL – Transcript of Testimony of Dr. Paul Mannheimer from June 6-10, 2022 Hearing Transcript, *Masimo Corp. et al. v. Apple Inc.*, ITC Inv. No 337-TA-1276
2078	CONFIDENTIAL – Transcript of Testimony of Dr. Stephen Waydo from June 6-10, 2022 Hearing Transcript, *Masimo Corp. et al. v. Apple Inc.*, ITC Inv. No 337-TA-1276
2079	CONFIDENTIAL – Transcript of Testimony of Dr. Vivek Venugopal from June 6-10, 2022 Hearing Transcript, *Masimo Corp. et al. v. Apple Inc.*, ITC Inv. No 337-TA-1276
2080	CONFIDENTIAL – ITC Exhibit CX-0289C – Designated Portions of February 10, 2022 Deposition of Paul Mannheimer

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2081	CONFIDENTIAL – ITC Exhibit CX-0299C – Designated Portions of February 18, 2022 Deposition of Stephen Waydo
2082	CONFIDENTIAL – ITC Exhibit CX-0295C – Designated Portions of February 11, 2022 Deposition of Tao Shui
2083	CONFIDENTIAL – ITC Exhibit CX-0007C – Email from Brian Land to Paul Mannheimer et al.
2084	CONFIDENTIAL – ITC Exhibit CX-0175C – Apple Organization Chart
2085	CONFIDENTIAL – ITC Exhibit CX-0177C – Apple Presentation
2086	CONFIDENTIAL – ITC Exhibit CX-0185C – Apple Presentation
2087	Kim, Gina, "Masimo Wants $3B From Apple Over Smartwatch IP, Jury Told." Law360, April 5, 2023 (https://www.law360.com/articles/1593689/masimo-wants-3b-from-apple-over-smartwatch-ip-jury-told)
2088	ITC Exhibit CX-1616 – Fowler, Geoffrey, "The new Apple Watch says my lungs may be sick. Or perfect. It can't decide." Washington Post, September 23, 2020 (https://www.washingtonpost.com/technology/2020/09/23/apple-watch-oximeter/)
2089	CONFIDENTIAL – ITC Exhibit CX-1793C – Apple Presentation
2090	CONFIDENTIAL – ITC Exhibit CX-1800C – Email from Adrian Perica to Steve Hotelling, et al.
2091	William, Andrews, "Fitbit Update Lets You Quickly Check Your Blood Oxygen Saturation." Forbes, Sept. 9, 2020 (https://www.forbes.com/sites/andrewwilliams/2020/09/09/fitbit-update-lets-you-quickly-check-your-blood-oxygen-saturation/?sh=5d6ecb55e76a)
2092	"Track Your SpO2 to Uncover Changes in Your Wellbeing," Fitbit, Sept. 7, 2020 (https://blog.fitbit.com/track-your-spo2/)
2093	CONFIDENTIAL – ITC Final Initial Determination

EX1036	CONFIDENTIAL – Transcript of Testimony of Ueyn Block from June 6-10, 2022 Hearing Transcript, *Masimo Corp. et al. v. Apple Inc.*, ITC Inv. No 337-TA-1276
EX1037	CONFIDENTIAL – Transcript of Testimony of Saahil Mehra from June 6-10, 2022 Hearing Transcript, *Masimo Corp. et al. v. Apple Inc.*, ITC Inv. No 337-TA-1276
EX1038	ITC Exhibit RX-0335
EX1039	ITC Exhibit RX-0504
EX1040	ITC Exhibit RX-0508
EX1041	ITC Exhibit RX-0632

In addition to the exhibits listed above, I have also considered Masimo's Patent Owner Preliminary Responses in these IPRs, the Institution Decisions in these IPRs, all other documents that Apple produced in response to Masimo's Motion for Additional Discovery, the parties' public Petitions for Review of the Final Initial Determination and the parties' public Responses to those Petitions in the Investigation, and to the extent not listed here, any other documents that I cite in this declaration.

III. LEVEL OF ORDINARY SKILL

5. For purposes of this declaration, I have continued to apply the definition of a person of ordinary skill in the art ("POSITA") that Apple proposed. *See* EX2002-1291 at ¶¶ 31-32. I have been informed and understand that obviousness must be evaluated from the perspective of a POSITA as of the effective filing date

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of the ’745 Patent. I have been informed and understand that the effective filing date of the ’745 Patent is July 2, 2015, based on the earliest priority date of the ’745 Patent. My analysis and opinions are based on the perspective of a POSITA as of the effective filing date of the ’745 Patent.

IV. CLAIM CONSTRUCTION

6. Independent Claims 1 and 20 both require “a plurality of light-emitting diodes configured to emit light in a first shape” and a “material configured to ***change the first shape into a second shape***.” In my opinion, the claim language, the specification, the prosecution history, and the parties’ agreements in the ITC Investigation all support a construction of the phrase “change the first shape into a second shape” that includes that the “second shape” must be a “a shape different from the first shape.” In other words, the claims require a material that is configured to change the first shape into a shape different from the first shape.

7. First, a POSITA reading the claim’s plain language would have understood that the phrase requires the material to “***change*** the first shape into a second shape.”[1] The requirement that there be a “change” would indicate to a POSITA that the second shape must be different than the first shape. I note this is

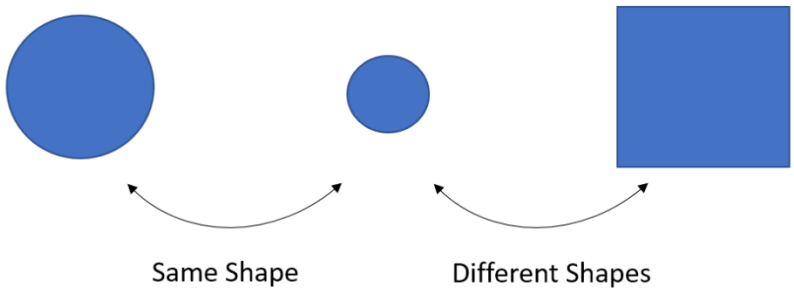
[1] All emphases are added unless stated otherwise.

consistent with the common meaning of the word "change," which is "[t]o make different." *See* EX2072.

8. Second, the specification also indicates to a skilled artisan that the claim phrase required that the second shape must be different than the first shape. As I explained previously, the specification contains several examples of a material changing a first shape into a second shape. *See* EX1001 at 7:63-8:14, 10:65-11:2; EX2002-1291 at ¶ 36; EX2002-1465 at ¶ 36.

9. Third, as I explained in my original declarations, I understand that during prosecution Masimo overcame a prior art rejection that included a lens by explaining that an analogous claim limitation required a change in the shape of the emitted light—not just a change in size. *See* EX2002-1291 at ¶¶ 38-43; EX2002-1465 at ¶¶ 38-43. As I explained previously, the prosecution history shows that the "first shape" and "second shape" limitations were claim amendments that Masimo made to overcome prior art, and that those amendments "reflect a change in shape of emitted light beyond a change in size, defined over the Examiner's citation of judicial notice of emitted light passing through a lens." *See* EX2002-1291 at ¶ 42; EX2002-1465 at ¶ 42. The prosecution history further confirms that the claims require a change in the shape of the light and that a change in size is not considered a change in shape. For example, if the first shape of light were a circle, a smaller

circle would not be considered a second shape. But a square would be considered a different shape than a circle.



10. Fourth, the ITC also agreed that the "second shape" is "a shape different from the first shape." I understand that on January 10, 2023, the ITC issued its Final Initial Determination on Violation of Section 337 in *In the Matter of Certain Light-Based Physiological Measurement Devices and Components Thereof*, Inv. No. 337-TA-1276 ("Investigation"). The ITC construed "second shape," as used in the claim phrase, to have its "plain and ordinary meaning, which the parties agree is 'a shape different from the first shape.'" EX2093 at 179-180. I understand that after the ITC issued its Final Initial Determination, Apple confirmed that the ITC applied the "correct construction" of "second shape," which is a shape different from the first shape. EX2075 at 36.

11. Thus, in my opinion, the plain language of the claims, the specification, the prosecution history, and the parties' prior agreed-upon plain meaning construction that was adopted by the ITC, the phrase "change the first shape into a

second shape" means that the "second shape" must be "a shape different from the first shape."

12. I have reviewed the March 24, 2023 deposition transcript for Apple's expert, Dr. Brian Anthony. Based on my review, I believe Dr. Anthony and Apple interpreted the "second shape" claim limitation in these IPRs in a way that is materially different than how it was interpreted in the ITC Investigation. Dr. Anthony admitted that Apple never informed him about the prior constructions before he signed his IPR declaration. EX2071 at 76:10-16, 79:8-84:10. However, Dr. Anthony's testimony shows that he interpreted "second shape" in a way that differs from the construction Apple previously agreed was the plain meaning. The ITC Initial Determination stated all parties agreed that "second shape" is "a shape different from the first shape." EX2093 at 179-180. But Dr. Anthony refused to agree that the shapes must be different and instead indicated that he believes the "first shape" and "second shape" can be the same shape:

> Q. Would a person of ordinary skill in the art understand that if a first shape has to change into a second shape, second shape has to be different than the first shape?
>
> A. I think a person skilled in the art reading this would read it in the entire context; such that the shape is changed and the person would also understand that the shape that is coming out of the – that the first shape is a function of the materials, the arrangement of the lights. The second shape is a function of materials, the curvature of the human body. And

> that there is a first shape and a second shape and they are being changed from one to the other. ***It's a very degenerate solution to have the exact same shape. Doesn't preclude that it could be.*** But person skilled in the art would know a first shape and a second shape.

EX2071 at 108:9-109:5; *see also id.* at 104:3-113:6 (refusing to confirm the shapes must be different). That is not correct. As I explained above, and as Apple previously agreed, the claims require that the "first shape" and "second shape" be different. Apple's Petitions and Dr. Anthony's declarations do not show, for example, that their proposed combination of Sarantos and Shie would result in a "second shape" that is different from the "first shape."

13. Additionally, as I noted in my original declaration, Apple's attempt to equate the "material configured to change the first shape into a second shape" with a diffuser would eliminate the requirement that the shapes be different. *See* EX2002-1291 at ¶¶ 45-46; EX2002-1465 at ¶¶ 45-46. Claims 15 and 19 of the '745 Patent further confirm my opinion. Claim 15 recites "a light diffusing material" but does not require that material to change a first shape into a second shape. Claim 19, which depends from Claim 15, adds the limitation "wherein the light diffusing material is configured to change the first shape into a second shape." *See* EX1001 at Claims 15, 19. I have been informed and understand that when a dependent claim adds a particular limitation, there is a presumption that the limitation is not present in the independent claim. Thus, the claims confirm that a "light diffusing material" does

not necessarily, by itself, change a first shape of light into a second shape of light. I also understand that the ITC similarly agreed that "light diffusion, in itself, does not necessarily provide changes in 'shape.'" EX2093 at 190 n.71.

V. DESCRIPTION OF APPLE'S ASSERTED REFERENCES

A. Iwamiya (EX1004)

14. U.S. Patent No. 8,670,819 to Iwamiya et al. is titled "OPTICAL BIOLOGICAL INFORMATION DETECTING APPARATUS AND OPTICAL BIOLOGICAL INFORMATION DETECTING METHOD." Iwamiya discloses an optical sensor built into a wristwatch that can measure "biological information." EX1004 at 5:54-67. The only example of "biological information" disclosed in Iwamiya is a "pulse wave" which measures pulse rate. EX1004 at 9:4-5. Iwamiya does not mention measurement of oxygen saturation. Iwamiya also identifies a problem where melanin pigment in the skin can absorb light with a wavelength under 600 nm such that the signal received is too weak to detect a pulse wave. EX1004 at 1:53-2:6. To address that problem, Iwamiya uses a single wavelength of light at 940 nm. *Id.* at 10:34-43. Iwamiya also teaches the use of an optical filter placed over the light detector to filter out light with a wavelength under 900 nm to "alleviate[] an influence from a measurement change due to external light, such as sunlight." *Id.* at 8:38-47.

[redacted]

B. Sarantos (EX1005)

15. U.S. Patent No. 9,392,946 to Sarantos et al. is titled "HEART RATE SENSOR WITH HIGH-ASPECT-RATIO PHOTODETECTOR ELEMENT." EX1005 at Title. Sarantos teaches improvements to heart rate sensors by using so-called "high-aspect-ratio" (HAR) photodetector elements which differ from conventional photodetectors that have a square aspect ratio. *Id.* at 9:48-10:15. Sarantos explains that the HAR photodetectors are able to improve light collection capabilities while still having substantially the same active area as a conventional square photodetector. *See id.* at 10:27-50, FIG. 5. Sarantos explains that the concepts discussed in his patent are "discussed primarily with respect to light sources that emit green light, e.g., wavelengths in the range of 500 nm to 550 nm, although it is contemplated that the photodetector element concepts discussed herein may see similar performance with light sources that emit light predominantly in the 500 nm to 600 nm range, which includes yellow light as well as some light orange light." *Id.* at 18:35-41. Sarantos also explains that the invention is "not tailored for use in other spectrums, such as the red or infrared spectra," which Sarantos noted would be the wavelengths used for measuring blood oxygenation levels. *Id.* at 18:44-51.

C. Venkatraman (EX1006)

16. U.S. Patent Application Publication 2014/0275854 to Venkatraman et al. is titled "WEARABLE HEART RATE MONITOR" and discloses a pulse rate

monitor worn on the wrist. EX1006 at Abstract, FIGS. 2A-2B. I note, however, that Venkatraman uses paragraph numbers, but not columns and line numbers. Apple's petitions and Dr. Anthony's declarations cite to Venkatraman using column and line numbers, which are unclear.

D. Shie (EX1007)

17. U.S. Patent No. 6,483,976 to Shie et al. is titled "OPTICAL ELEMENT HAVING AN INTEGRAL SURFACE DIFFUSER" and was originally assigned to Physical Optics Corporation. EX1007 at Title. Shie describes over a dozen different types of optical elements depicted across 22 figures (counting subfigures). *Id.* at FIGS. 1a-11. Shie explains that these various optical elements have a "plurality of surface micro-structures." *Id.* at Abstract. However, Shie does not mention that any of the various optical structures have applications in a physiological sensor, let alone a pulse oximeter. *See generally id.* Nor does Shie explain any benefits that any of the optical structures might provide in a physiological sensor. Shie has nothing to do with physiological sensors.

E. Savant (EX1012)

18. U.S. Patent 6,158,245 to Savant is titled "HIGH EFFICIENCY MONOLITHIC GLASS LIGHT SHAPING DIFFUSER AND METHOD OF MAKING." EX1012 at Title. Both Savant (EX1012) and Shie (EX1007) were originally assigned to Physical Optics Corporation and both list Gajendra Savant as

an inventor. The Background of the Invention section in Savant describes a "Light Shaping Diffuser™ (LSD®)" as a "transparent or translucent structure having an entrance surface, an exit surface, and light shaping structures formed on its entrance surface and/or in its interior." EX1012 at 1:16-19.

19. However, Savant does not disclose any drawings of any particular "LSD." Notably, Savant has no relation to physiological sensors. It does not describe any physiological sensors, let alone a pulse oximeter, nor does it explain that an LSD would be used in a physiological sensor or any benefits that an LSD would provide to a physiological sensor. Rather, the disclosure of Savant focuses on the manufacturing process for an LSD. *See generally* EX1012.

VI. A POSITA WOULD NOT HAVE HAD A REASONABLE EXPECTATION OF SUCCESS IN MEASURING OXYGEN SATURATION AT THE WRIST AND OBJECTIVE INDICIA CONFIRMS NONOBVIOUSNESS

20. As explained above, I understand that obviousness is to be assessed as of the July 2, 2015 effective filing date for the '745 Patent. As I explained previously in my original declaration, Claims 9 and 18 require the measurement of oxygen saturation at the wrist. EX2002-1291 at ¶ 74. Apple's obviousness arguments do not demonstrate that a person of ordinary skill in the art would have reasonably expected success in making a device that can measure oxygen saturation from the wrist as of the effective filing date for the '745 Patent.

21. In my original declaration, I explained, based on what was publicly available in the ITC briefs, that Apple's engineers expressed skepticism that pulse oximetry could be performed at the wrist and that others, including Apple itself, failed for years to develop such a device. *See* EX2002-1291 at ¶¶ 86-90, 120-121, 177-196. I understand that Apple was ordered to produce certain documents and testimony from the Investigation in this IPR. I have reviewed the produced documents and testimony. The produced documents and testimony confirm that a POSITA would not have had a reasonable expectation of success in measuring oxygen saturation at the wrist as of the '745 Patent's July 2, 2015 effective filing date.

A. Apple's Highly-Skilled Engineers Expressed Skepticism for Pulse Oximetry at the Wrist and Revealed that Others Had Failed

22. In late 2014, Apple hired Dr. Paul Mannheimer to begin looking into pulse oximetry at the wrist for the Apple Watch. EX2077 at 996:9-997:8. Brian Land, who is the chief of Apple's Health Sensing Hardware Group and who led development of the health sensor hardware in the Apple Watch, testified that EX2076 at 954:15-955:9, 963:5-15; EX2008 at 39:21-25. Mannheimer holds a Ph.D. in biomedical engineering and had spent over twenty years designing pulse oximeters at one of Masimo's major competitors,

Nellcor, and considered his specialty to be the physio-optics of pulse oximetry. *See* EX2077 at 994:2-25, 1009:1-8; EX2080 at 180:22-181:4.

23. Mannheimer explained that his first assignment at Apple was to EX2080 at 173:9-173:13; *see also* EX2077 at 996:25-997:5, 1012:12-25. Mannheimer testified, internally to my head **rolling my eyes**, thinking, as I'd thought of it in the past with other clients, like **good luck with that**." EX2080 at 173:14-174:1; *see also* EX2077 at 1012:12-25. EX2080 at 174:2-6.

24. He testified:

[redacted]

EX2080 at 174:7-18; *see also* EX2077 at 1013:1-6 (same). Mannheimer also explained that the products he previously worked on "operated on a much more vascularized tissue bed, usually fingers or forehead, [redacted] but that in contrast, "[t]he wrist is just an incredibly different beast" because [redacted] EX2077 at 998:21-999:11. It ultimately took Apple six years, [redacted] to develop the blood oxygen feature. EX2080 at 174:19-175:5.

25. Other Apple engineers also shared Mannheimer's skepticism for pulse oximetry at the wrist. Dr. Stephen Waydo is the director of Apple's team for health algorithms on the Apple Watch. EX2078 at 919:1-8. Waydo spent four and a half years working at a medical device startup trying to build a noninvasive glucose measuring device before working at Apple. *Id.* at 920:3-6. Waydo testified that his reaction to receiving the assignment to help develop the blood oxygen feature for the Apple Watch was "both excited and, I'd say, intimidated." EX2008, 938:3-12. Waydo also explained that it was "**extremely challenging**" to develop the blood oxygen feature in the Apple Watch and [redacted] EX2081 at 165:12-16. He also testified:

[redacted]

A. ***The wrist is one of the most difficult places on the body to do almost every physiological measurement***.

EX2081 at 166:4-166:18.

26. Waydo also testified that oxygen saturation and pulse rate measurements are "very different," and that measuring oxygen saturation requires solving "a different set of problems." EX2008 at 937:2-938:24. EX2078 at 923:24-924:4. *Id.* at 924:5-11. Waydo also explained that his team of engineers were "just a small piece of the overall puzzle" but that they spent just on developing the algorithm architecture for the oxygen saturation feature, totaling between "20 or 30,000 hours of engineering time." *Id.* at 925:23-926:6.

27. Another Apple engineer, Dr. Tao Shui, who also helped develop the oxygen saturation feature in the Apple Watch, also testified:

> The watch is worn on the wrist, and the wrist is well known for its lack of signal.

EX2082 at 108:13-21.

28. Brian Land also testified that "we also had to work [] at the wrist, which was ***unprecedented*** – EX2076 at 963:19-964:6. EX2076 at 962:25-963:9 EX2080 at 174:19-175:5 Land also testified

that [redacted] *Id.* at 984:17-21.

29. The testimony from Apple's experienced engineers, including Apple's lead engineer on the oxygen saturation sensor project, mirrors my understanding. As of 2015, it was my understanding and experience that pulse oximetry measurements at the wrist were extremely challenging. Indeed, between 2005-2008, I worked on designing a reflectance pulse oximeter for military and first responder applications at a company I formed with my colleague, Professor Yitzhak Mendelson. *See* EX2002-1291 at ¶¶ 55-58. We ultimately chose the forehead as the intended measurement site for the pulse oximeter. My understanding at the time was that other potential measurement sites like the wrist and the finger were not viable. The finger was not viable because it would have been obtrusive for military personnel and first responders who need to use their hands. The wrist also was not viable due to the poor quality of PPG signals obtained there. Thus, the testimony of Apple's various engineers is consistent with my own experience and understanding. Apple's Petition and Dr. Anthony's declaration are incorrect in stating that "wrist-worn pulse oximetry sensors, such as that described in Sarantos, were well-known in the art." 1291 Pet. 20; EX1003-1291 at ¶ 48. I further note that Dr. Anthony (and the Petition) do not identify or cite any examples of the allegedly "well-known" wrist-worn pulse oximetry sensors. 1291 Pet. 20; EX1003-1291 at ¶ 48.

B. Apple's Internal Development Documents Confirm Their Engineers' Skepticism and the Difficulties of Pulse Oximetry at the Wrist as of July 2015

30. Apple's internal development documents are also consistent with Apple's engineers' testimony during the ITC Investigation. For example, Brian Land testified EX2076 at 962:25-963:4. *See* EX2085; EX2076 at 981:19-983:1, 989:21-990:9. EX2085 at 6. *Id.* at 7.

EX2085 at 8-9.

Id. at 13. "Conventional sensing methods do not result in waveforms that are consistent enough for SpO_2 measurements at the wrist." *Id.*

[redacted] *Id.* [redacted] These statements show how actual engineers, who have significantly more skill than the ordinary level of skill in the art, viewed pulse oximetry at the wrist [redacted]. This is also consistent with my understanding at the time that conventional pulse oximetry at the wrist was not feasible and that innovation was needed.

32. Apple's documents show [redacted] *See* EX2083. [redacted] *Id.* [redacted] *Id.* at 7.

33. As I noted in paragraphs 188-192 of Exhibit 2002-1291, it was not until Apple redesigned the optical sensor in the Apple Watch to include a new optical material called a microlens array (MLA) that changed the shape of light that Apple was able to achieve pulse oximetry at the wrist. [redacted]

EX2077 at 1020:8-20.

EX2079 at 824:13-23, 826:13-20.

EX2085 at 13.

34. The testimony of Apple's engineers Dr. Paul Mannheimer, Brian Land, Dr. Stephen Waydo, Dr. Tao Shui, and Dr. Ueyn Block demonstrate skepticism for measuring oxygen saturation at the wrist due to challenges with the physiology of the wrist as of the effective filing date for the '745 patent and after. it ultimately took Apple years to develop the oxygen saturation sensor for the Apple Watch Series 6. Thus, the evidence also shows that others, including Apple, failed to achieve oxygen saturation

measurements at the wrist as of the ’745 Patent’s effective filing date. Given the struggles of Apple’s highly-educated and highly-experienced engineers even after the ’745 Patent’s July 2, 2015 effective filing date, a POSITA with less education and less experience than Apple’s engineers would not have had a reasonable expectation of success in developing a device that measures oxygen saturation at the wrist as of the ’745 Patent effective filing date. That is consistent with my understanding at the time that measuring oxygen saturation at the wrist was not yet feasible. Thus, in my opinion, a POSITA would not have had a reasonable expectation of success in measuring oxygen saturation at the wrist at the time of the ’745 Patent.

C. Apple’s “Supplemental Information” Does Not Demonstrate a Reasonable Expectation of Success for Measuring Oxygen Saturation at the Wrist as of July 2015 or Negate the Objective Indicia of Nonobviousness

35. I understand that Apple has filed “supplemental information” in the IPRs. I understand that Apple identified the “supplemental information” as testimony from Apple engineers Ueyn Block (EX1036) and Saahil Mehra (EX1037), and testimony from Apple’s expert witness in the ITC, Dr. Steven Warren, (found in EX2008, which is a transcript of the public sessions of the entire ITC hearing), and ITC exhibits RX-0335 (EX1038), RX-0504 (EX1039), RX-0508 (EX1040), RX-0632 (EX1041). However, neither Apple’s Petition nor Dr. Anthony’s declaration referenced or made an argument about any of the “supplemental

information" and so I do not know how the "supplemental information" relates to either the Petition or Dr. Anthony's declaration. Regardless, I have reviewed the "supplemental information" and it does not change my opinion that a POSITA would not have had a reasonable expectation of success in measuring oxygen saturation at the wrist as of July 2015 or that the objective indicia also discussed above show that the '745 Patent claims that require oxygen saturation at the wrist would not have been obvious.

36. Dr. Block's testimony further confirms my opinion that a POSITA would not have had a reasonable expectation of success in measuring oxygen saturation at the wrist as of the earliest effective filing date of the '745 Patent. EX1036 at 902:13-19.

37. I have reviewed Dr. Mehra's testimony, and it also does not change my opinion.

[redacted] EX2008 at 852:1-6. Thus, in my opinion, Dr. Mehra's testimony is not relevant to the skepticism or expectation of success as of the earliest effective filing date of the '745 Patent's invention.

38. Dr. Steven Warren's testimony and ITC exhibits RX-0504, RX-0508, and RX-0632 also do not change my opinion. As an initial matter, I understand that Dr. Warren is not Apple's expert in these IPRs and also was not Apple's expert with respect to the '745 Patent in the ITC Investigation. In the ITC Investigation, Dr. Warren presented opinions regarding U.S. Patent Nos. 10,912,501, 10,912,502, and 10,945,648, which are unrelated to the '745 Patent. I understand, however, that in the ITC, Dr. Warren testified about some lab projects involving undergraduate students and that Apple referred to exhibits RX-0504, RX-0508, and RX-0632 as relating to Dr. Warren. I understand that the ITC already thoroughly considered all of Dr. Warren's testimony and exhibits and found "there is little evidence that wrist-based blood oxygen levels were successfully measured in a watch-type

[redacted]

environment." ID at 116-117. The ITC Initial Determination also stated that while Warren testified about his students taking measurements from various locations including the wrist, "[h]e provided no testimony regarding the results of those measurements." *Id.* at 117. I have carefully reviewed Dr. Warren's testimony and the exhibits RX-0504, RX-0508, and RX-0632. In my opinion, none of these exhibits or Dr. Warren's testimony show successful wrist-based oxygen saturation measurements or that a POSITA would have had a reasonable expectation of success in measuring oxygen saturation at the wrist.

39. For example, RX-0632 (EX1041) appears to be a photograph, but it does not show any successful measurements of SpO_2 at the wrist. RX-0508 (EX1040) only references "different body locations (*e.g.*, wrist, forehead or ear lobe) that have noticeably different vascular profiles" but only presents data from the thumb. EX1040 at 7, 12; EX2093 at 117. It does not show that any measurements of SpO_2 from the wrist were successful. Rather, RX-0508 recognizes that PPG signals from the wrist are different than signals obtained at other locations. ("[Students] are also asked to evaluate the differences between PPG signals acquired at different body locations (e.g., wrist, forehead, or ear lobe) that have noticeably different vascular profiles."). EX1040 at 7. In addition, merely obtaining a PPG signal is different from successfully measuring oxygen saturation. Unlike pulse rate measurements, which can be performed by counting repeated features in a PPG

waveform (e.g., counting peaks in the waveform), pulse oximetry depends heavily on the quality of at least two PPG signals. That is because pulse oximetry calculations need to compare the relative AC and DC components of at least two PPG signals at two different wavelengths. Noisy or unstable PPG signals can prevent measurement of oxygen saturation. A signal that is good enough to measure pulse rate may not be of sufficient quality to measure oxygen saturation. RX-0504 (EX1039) also does not show any successful measurements from the wrist. EX1039. RX-0504 only presents red and IR waveforms from the finger and head, but does not report any successful pulse oximetry measurements. Moreover, there are no corresponding waveforms shown from the wrist, let alone any successful measurements of SpO_2 from the wrist. *See* EX1039; *see also* EX2093 at 117. Although RX-0504 lists "Wrist" under a heading titled "Viable and Unobtrusive Measuring Sites," the remainder of RX-0504 does not have any data supporting the idea that pulse oximetry could be carried out at the wrist. Indeed, to the extent that "viable" has any meaning in the context of RX-0504, the only data is simple waveform data and not pulse oximetry data. As mentioned, no such pulse oximetry data is reported for measurements at the head (specifically the temporal artery) and finger. Regardless of what the ambiguous reference to the "Wrist" in RX-0504 was intended to mean, it does not reflect the understanding in the art at the time. As I discussed above, multiple Apple engineers, each of whom are far more experienced

than a POSITA, expressed skepticism about pulse oximetry at the wrist and explained the difficulties with measuring oxygen saturation at the wrist.

40. Finally, RX-0335 (EX1038) also does not change my opinion. RX-0335 is U.S. Patent No. 5,830,137 ("Scharf"). EX1038. I understand that Scharf was cited by the examiner during prosecution of a parent application and that Masimo's claims involving a "first shape" and "second shape" were already allowed over Scharf, as noted in my original declaration. *See* EX2002-1291 at ¶¶ 39-43. Scharf also does not show that a POSITA would have had a reasonable expectation of success in measuring oxygen saturation at the wrist. Scharf is a patent that describes a contemplated sensor design. It does not show whether a POSITA would have had a reasonable expectation of success in measuring oxygen saturation at the wrist as of July 2015. In particular, Scharf relies on a very specific sensor design that is not compatible with Apple's proposed combinations.

41. Scharf does not speak to whether a POSITA would have had a reasonable expectation of success in measuring oxygen saturation at the wrist with the Iwamiya and Sarantos or Sarantos and Shie combinations that Apple proposed. Scharf proposes a sensor design with an unusual choice of two wavelengths of green light at 560 nm and 577 nm, whereas the obviousness combinations that Apple proposed are all based on pulse oximetry carried out using red and infrared light. EX1038 at 2:34-52. Scharf's green-light disclosure has no bearing on whether a

POSITA would have a reasonable expectation of success in measuring oxygen saturation at the wrist using the combinations of prior art that Apple proposed. In fact, as I explain further below, Iwamiya teaches away from using visible light, including light below 600 nm, and also has an optical filter that would block the wavelengths disclosed in Scharf. *See infra* Section VII.A.1.

42. Additionally, I am skeptical that Scharf's disclosure regarding two wavelengths of green light would work for measuring oxygen saturation at the wrist. I am aware of no evidence showing that this unusual choice of wavelengths would work for pulse oximetry at the wrist. If Scharf's 560 and 577 nm approach could successfully measure oxygen saturation at the wrist, then I would have expected the industry would have moved towards this approach or at least there would be evidence of additional research applying this approach in clinical settings. But in my years of experience, I have never heard of anyone developing a pulse oximeter with Scharf's two-green-wavelength approach. I also could not find any research papers before the '745 Patent that describe or expand on Scharf's approach.

43. There are also specific problems with Scharf's 560 nm and 577 nm choice that likely explain why there hasn't been much, if any, further development on Scharf's idea. The two green wavelengths, 560 nm and 577 nm, are separated by only 17 nm, which is closer than the bandwidth of most LEDs. *See, e.g.,* EX1013 at 57 ("Typical LEDs have a *spectral bandwidth* in the range of 60 nm to less than 20

[redacted]

nm, with visible LEDs usually having smaller bandwidths of approximately 25 nm and IR LEDs typically having larger bandwidths near 50 nm.") (italics in original). Scharf mentions this problem and suggests the use of "very narrow band" sources like laser diodes (which present their own safety problems in a consumer device) or using "narrow band" LEDs with "ultra-narrow band" filters which can be impractical. EX1038 at 2:34-52. But using narrow bandwidth LEDs with ultra-narrow band filters also may not work because LED peak wavelengths are known to shift with temperature and can also vary due to manufacturing imperfections. *See, e.g.,* EX1013 at 62-63, 66. Even small shifts in the peak wavelength would result in the optical signals being blocked by Scharf's ultra-narrow band filters, which would dramatically reduce the measured light signals (due to the closeness of the green wavelengths monitored in Scharf, two ultra-narrow band filters would be necessary). Ultimately, in my opinion a POSITA would have believed that even small changes in peak wavelength would render Scharf's approach unusable because there is not sufficient light that passes through the filter. Green light is also known to not penetrate the tissue as deeply as red wavelengths, which makes it harder for green light to interact with the blood vessels. For example, Iwamiya expressly teaches against the use of light below 600 nm and opts for 940 nm for that reason. EX1004 at 1:62-2:6, 10:34-43, 11:43-54. Webster also explains that light below 600 nm is not desirable for pulse oximetry. EX1013 at 45 ("Different reasons lead to the most

common choice for wavelengths used in pulse oximetry. The red skin pigmentation absorbs a great amount of light at wavelengths shorter than 600 nm and therefore it is not desirable to measure light absorbance in this range."). Thus, it is not clear whether a two-green-wavelength approach would work at the wrist for oxygen saturation. Given that Scharf describes a different approach to pulse oximetry than Apple's prior art, the apparent lack of any further development of Scharf's approach, and the skepticism of Apple's engineers many years after Scharf, I do not believe that a POSITA would have had any reasonable expectation of success in combining Apple's proposed prior art combinations to measure oxygen saturation at the wrist.

VII. IPR2022-01291 GROUNDS 1A AND 1B DO NOT ESTABLISH OBVIOUSNESS

44. Ground 1A addresses Claims 1 and 9 based on Iwamiya combined with Sarantos, while Ground 1B addresses Claims 15, 18, 20, and 27 based on Iwamiya combined with Sarantos and Venkatraman. My original opinions regarding Grounds 1A and 1B are set forth in Exhibit 2002 at ¶¶ 73-105. Below, I present additional opinions that are supplemental to my original opinions expressed in Exhibit 2002.

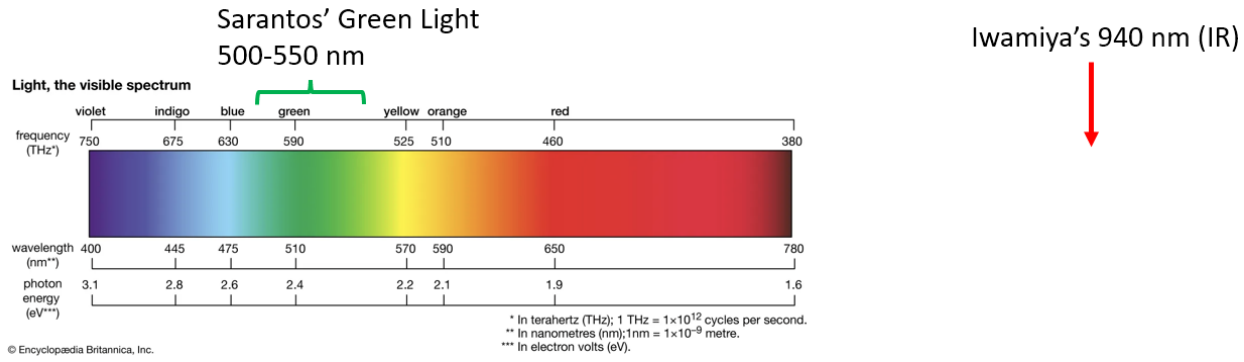
45. The discussions herein regarding independent Claims 1, 15, and 20 are also applicable to my analysis for IPR2022-01465.

[redacted]

A. Claims 9 and 18: Measuring Oxygen Saturation at the Wrist Would Not Have Been Obvious Based on Iwamiya and Sarantos

1. Iwamiya Teaches Away from a Combination with Sarantos

46. Apple argues that "a POSITA would have been motivated to determine oxygen saturation using Iwamiya's physiological sensor, based on the teachings of Sarantos." 1291 Pet. at 20. But, in my opinion, a POSITA would not have been motivated to combine Iwamiya with Sarantos because Iwamiya taught away from using the wavelengths that are the focus of Sarantos' disclosure. Iwamiya repeatedly explains that its sensor design uses infrared light (specifically at 940 nm) to avoid a problem where light at lower wavelengths would be absorbed by melanin in the skin, resulting in weak signals such that "biological information, such as a pulse wave, cannot be detected." EX1004 at 1:62-2:6, 21:38-22:12. As I annotated in the graphic below, Iwamiya's 940 nm light is at a very different wavelength than green or red light:

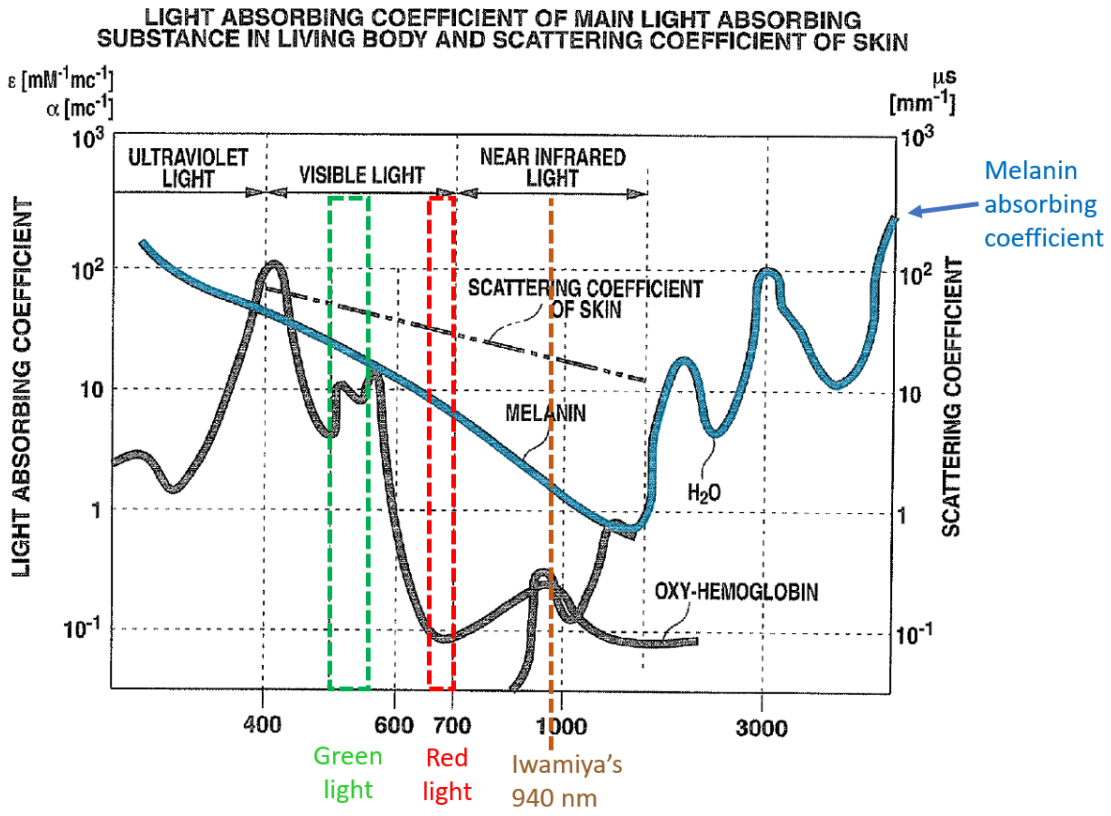


2073 (annotated).

[redacted]

47. Iwamiya explained that melanin pigment in the skin "has extraordinarily high absorbance in a wavelength band from ultraviolet light to visible light." EX1004 at 1:62-64. Thus, Iwamiya taught away from using UV or visible light. Iwamiya also specifically criticized the use of wavelengths at or below 600 nm. *Id.* at 1:64-2:6. Iwamiya repeatedly explains throughout its disclosure that the use of 940 nm light is to avoid the melanin absorption problem. *See* EX1004 at 6:31-34, 10:34-38, 11:43-49, 15:26-29, 20:51-55, 21:62-67, 22:24-31, 32:57-60, 42:44-48, 44:15-20. Iwamiya also goes to great lengths to avoid light below 900 nm, which includes UV and visible light, and dedicates substantial disclosure to teaching against light other than 940 nm. For example, Iwamiya's Figure 6 illustrates the melanin absorption problem with UV and visible light as compared with Iwamiya's 940 nm light.

[redacted]



EX1004 at Fig. 6 (annotated); *see also id.* at 1:62-2:6. In Iwamiya's Figure 6, annotated above, the melanin absorption coefficient (highlighted blue) is shown on a logarithmic scale. The figure shows that the absorption coefficient for green light (green box) is approximately 20 times higher than at 940 nm (brown line) and approximately eight times higher in the red spectrum (red box) than at 940 nm.

48. Iwamiya also explains that its light receiving unit has a peak sensitivity to light at 940 nm and significantly less sensitivity for other wavelengths. EX1004 at 8:29-37, Fig. 9 (annotated below). As shown in Figure 9, the relative sensitivity of the light receiving unit at Sarantos' 500-550 nm (green box) is only between 15-25% of the peak sensitivity at Iwamiya's 940 nm (brown line), and the relative

[redacted]

sensitivity for red wavelengths 660-700 nm (red box) is only around 50-60% of the peak sensitivity at 940 nm. Thus, Iwamiya's sensor has very little sensitivity to measurements of light in the visible spectrum and was not designed for taking such measurements.

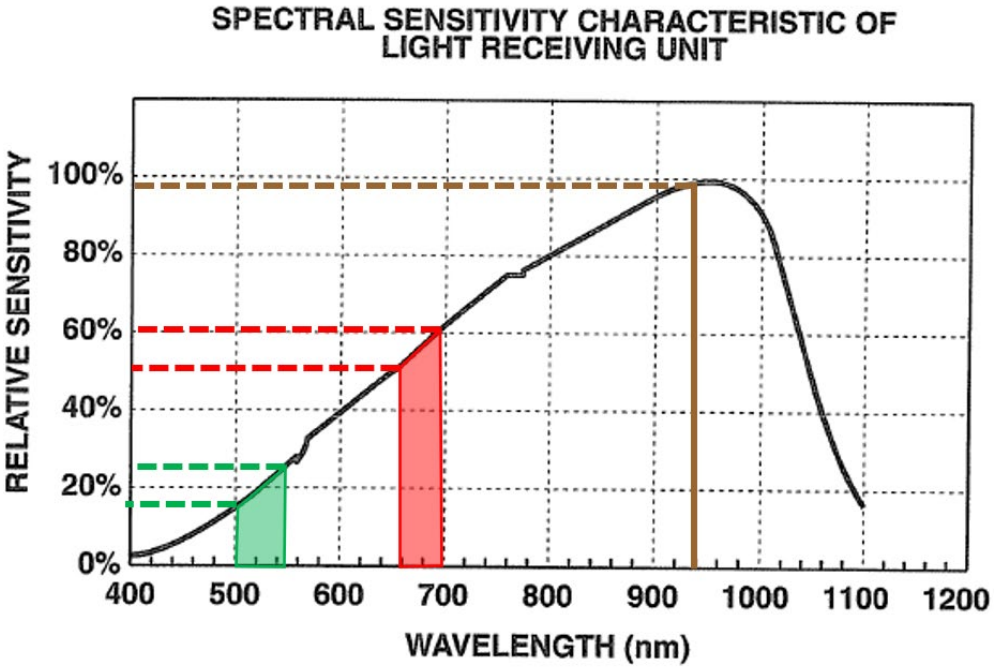


FIG.9

49. Because Iwamiya taught against using other wavelengths besides 940 nm, Iwamiya includes a filter which only transmits light above 900 nm and filters out light below 900 nm. *Id.* at 8:38-47, Fig. 8. Apple's proposed combination specifically relies on that filter for limitation [1.5]. *See* 1291 Pet. at 17-18. Iwamiya's Figure 8 shows that its filter has 0% transmittance for visible light, including for Sarantos' green (500-550 nm) wavelength, as well as for red (660-700

[redacted]

nm) and some infrared wavelengths (< approximately 850 nm). This means that no visible light, including green and red, would be able to pass through the filter.

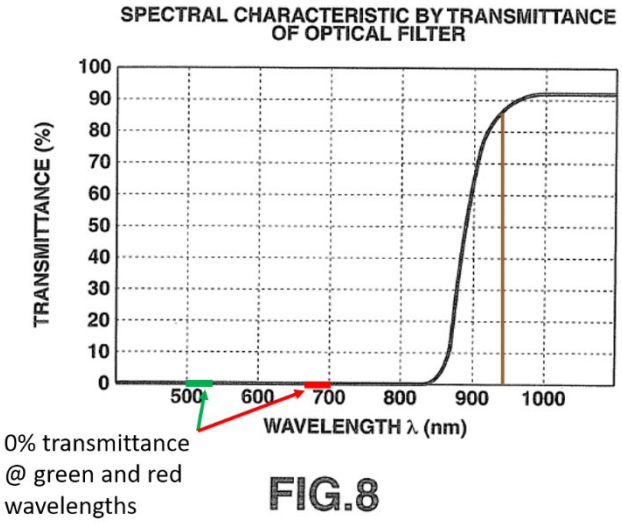


FIG.8

EX1004 at Fig. 8.

50. In contrast, Sarantos is focused on using light below 600 nm, as I explained previously. EX1005 at 18:35-51 (explaining that Sarantos' disclosure was discussed primarily with respect to 500-550 nm green light and may see similar performance with light up to 600 nm, but was not tailored to the red or infrared spectra); *see also* EX2002-01291 at ¶ 83. A POSITA would not have been motivated to combine Iwamiya and Sarantos because Iwamiya taught against using the wavelengths that Sarantos' disclosure focused on.

51. Additionally, Apple's proposed combination would be inoperable. Iwamiya's optical filter would filter out Sarantos' green wavelengths that are the basis for Sarantos sensor. It would also filter out the red wavelengths of light

(mentioned briefly in Sarantos) that are part of the Petition's combination because red light falls below the filter's cutoff (*e.g.*, well below 900 nm).

52. Thus, in my opinion, a POSITA would not have been motivated to combine Iwamiya and Sarantos to measure oxygen saturation because Iwamiya taught away from using Sarantos' disclosed wavelengths in combination with Iwamiya's sensor, and Iwamiya's optical filter would render the combination inoperable.

2. Apple Fails to Demonstrate that a POSITA Would Have Had a Reasonable Expectation of Success in Modifying Iwamiya Based on Sarantos to Measure Oxygen Saturation at the Wrist

53. Apple and Dr. Anthony argue that a POSITA would have had a reasonable expectation of success in modifying Iwamiya based on Sarantos to measure oxygen saturation at the wrist because, in their words, "wrist-worn pulse oximetry sensors, such as that described in Sarantos, were well-known in the art." 1291 Pet. 20; EX1003-1291, ¶ 48. But Apple's Petition and Dr. Anthony's declaration cited no evidence in support, other than Sarantos itself. Apple's and Dr. Anthony's unsupported argument is inconsistent with the testimony of Apple's lead engineer, Brian Land, who testified that "we also had to work across – at the wrist, which was unprecedented EX2076 at 963:19-964:6. Brian Land was the Apple engineer

[redacted]

in charge of developing the oxygen saturation sensor in the Apple Watch. EX2076 at 954:23-955:9; EX2084 [redacted] Given Land's specific role in leading the development of the pulse oximetry sensor for the Apple Watch and that he actually looked into the issue at the relevant time, his testimony that blood oxygen sensing at the wrist was "unprecedented" and that [redacted] is consistent with my understanding of the state of the art for pulse oximetry at the wrist at the time of the '745 Patent.

54. I also disagree with Apple's and Dr. Anthony's unsupported assertion that such devices were "well-known in the art." Apple and Dr. Anthony specifically mention "wrist-worn pulse oximetry sensors, ***such as that described in Sarantos***," but I am unaware of such a device ever existing as of the '745 Patent's July 2015 effective filing date. Indeed, as I pointed out originally, Sarantos' disclosure admits that the device is not tailored for the red and infrared spectra used for pulse oximetry. EX1005 at 18:35-51; *see also* EX2002-1291 at ¶ 81. Moreover, Sarantos is a patent filed by and assigned to Fitbit, Inc., a company that is well-known for making wearable fitness trackers. *See* EX1005 at Cover. If such a device described in Sarantos actually existed and was "well-known in the art" to the point that a POSITA could reasonably expect success in also building a wrist-based pulse oximeter, then

I would expect that device to be a Fitbit device. But I am unaware of any Fitbit device in existence as of July 2015 that could measure oxygen saturation, let alone measure it at the wrist. Indeed, based on my research, it apparently took Fitbit more than five years before it announced (in late 2020) that some of its devices might be able to measure SpO_2. EX2091; EX2092.

55. Additionally as I described above in Section VII, the testimony of Apple's engineers and its own development documents demonstrate that a POSITA would not have had a reasonable expectation of success in making a device that measures oxygen saturation at the wrist as of the '745 Patent's July 2, 2015 priority date. I also note that, consistent with the testimony and documents described in Section VII, Fitbit's director of research, Conor Heneghan, was quoted in a September 23, 2020 Washington Post article as stating, "It's a pretty hard technical problem to measure SpO_2 on the wrist." EX2088 at 4.

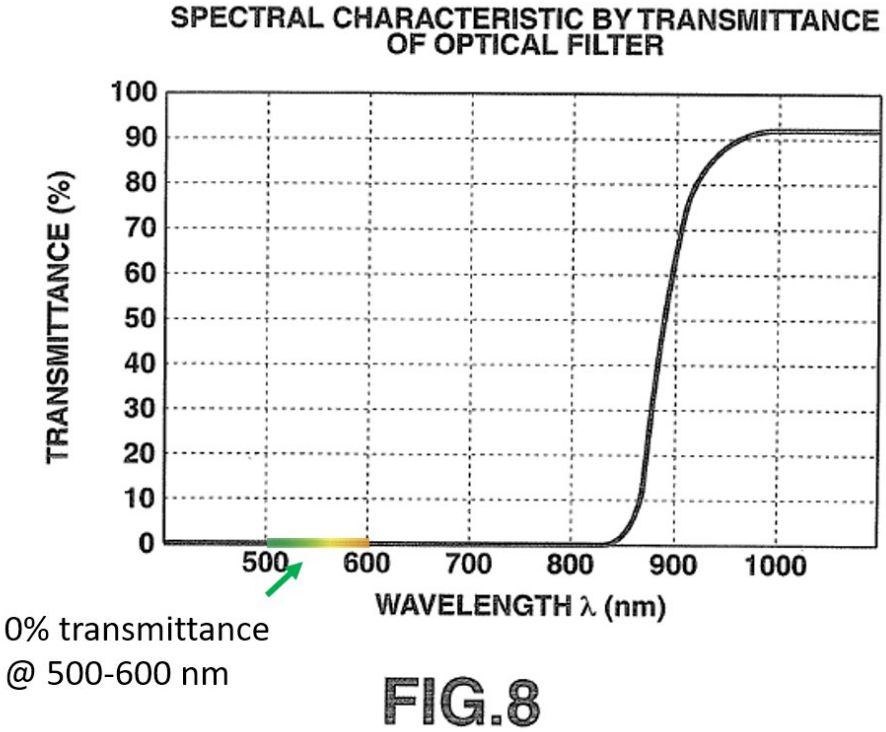
B. Claim 27: A POSITA Would Not Have Been Motivated to Combine Iwamiya with Sarantos to Add a Second Wavelength

56. As I explained previously, a POSITA would not have been motivated to combine Iwamiya and Sarantos to add a second wavelength because the combination would be inoperable due to the optical filter in Iwamiya. EX2002-1291 ¶ 91. Additionally, as I described above in Section VII.A.1, Iwamiya teaches away from a combination with Sarantos.

57. Apple also argues that the combination would "enable the sensor to perform a larger number of physiological measurements," but does not explain how that can be accomplished. 1291 Pet. 29. As I explained previously, Iwamiya only measures a pulse wave for pulse rate with infrared light at 940 nm. EX1004 at 2:5-6, 9:3-5, 11:13-18; EX2002-1291 at ¶ 76. Sarantos' disclosure is also focused on a pulse rate sensor that uses green light between 500-550 nm in wavelength. *See* EX2002-1291 at ¶ 81; EX1005 at 13:39-44, 8:39-58. A POSITA would have understood that Sarantos' mention of "blood oxygenation levels" was at most aspirational, based on Sarantos' statement that red and infrared light are "dramatically different wavelengths" than the green light it was intended for and that the Sarantos design was not tailored for red or infrared spectra. *Id.*; EX1005 at 18:35-51. While Sarantos also mentions that the disclosed concepts "may see similar performance" with yellow light and orange light up to 600 nm, Sarantos offers no further explanation and does not identify what that light would be used for. *Id.* A POSITA reading Iwamiya and Sarantos would not have understood that combining Iwamiya with Sarantos would result in the sensor performing a larger number of physiological measurements because Sarantos does not explain how to perform any different measurements than what Iwamiya already performs. Additionally, Iwamiya's optical filter 17 would also filter out all light under 900 nm in wavelength, including the green, yellow, and light orange light mentioned in

[redacted]

Sarantos between 500-600 nm. *See, e.g.*, EX1004 at Fig. 8, 8:38-47. This means that all light mentioned by Sarantos would have zero transmittance by the optical filter in Iwamiya and none of that light would be received by the detector in Iwamiya.



EX1004 at Fig. 8 (annotated).

Again, a POSITA would have understood that the combination would be inoperable for any wavelengths below 900 nm. And, as discussed, Iwamiya's detector is likewise optimized for detecting a 940 nm signal, but has dramatically lower sensitivity for green, yellow, or orange wavelengths of light.

[redacted]

C. Claims 1, 9, 20, 27: A POSITA Would Not Have Been Motivated, Except by Hindsight, to Add a "surface comprising a dark-colored coating" to Iwamiya

58. I set forth my original opinions in Exhibit 2002-1291 ¶¶ 92-101 that a POSITA would not have been motivated, except by hindsight, to add a dark-colored coating to Iwamiya's light shielding frame 18 based on Sarantos, as Apple's Petition argued. I have read the Institution Decision's discussion of this limitation and understand that the Board made a preliminary finding that "Patent Owner's arguments, including that Iwamiya needed no improvement and relies on a contrary principle of operation, and find them to be insufficient on the current record to overcome the rationale shown by Petitioner." Institution Decision at 18-21. I respectfully disagree with the Board's preliminary finding.

59. I believe that Apple relied on hindsight to piece together Iwamiya and Sarantos to add a dark-colored coating where no POSITA would have found it necessary or beneficial in Iwamiya. Apple's reliance on hindsight is particularly evident when considering its argument that a POSITA would have added an "in-mold label or other black or opaque material as disclosed by Sarantos in the light shielding frame 18 of Iwamiya to serve the purpose indicated by the component's name: shielding the photodiodes 9 from stray light, and thereby ensuring accuracy of the sensor." 1291 Pet. at 16. That argument relies on an assumption that Iwamiya's light shielding frame 18 does not already serve its intended purpose of

shielding light. But a POSITA would not have made that assumption. As I previously explained in EX2002-1291 ¶¶ 93-95, Iwamiya's light shielding frame already works to shield light, so adding a dark-colored coating is needlessly redundant. Apple's argument does not consider how a POSITA, with no knowledge of the '745 Patent, would have viewed the prior art. Instead, Apple's argument assumes that a POSITA would have ignored Iwamiya's teachings about its light shielding frame and would have assumed a problem with the light shielding frame that did not exist. A POSITA would not have made that assumption about the light shielding frame because Iwamiya already explains that it is light shielding. As I previously explained, Iwamiya specifically and repeatedly teaches the use of reflective materials to shield light. *See* EX2002-1291 at ¶¶ 96-98; EX2002-1465 at ¶¶ 75-77. Iwamiya explains, for example:

> [T]he holder portion 43 of the light receiving unit 33 is formed of a metal with a light shielding property, such as aluminum, and its surface is subjected to alumite treatment to have a reflection function. Thereby, the light receiving element 33a can be optically protected.

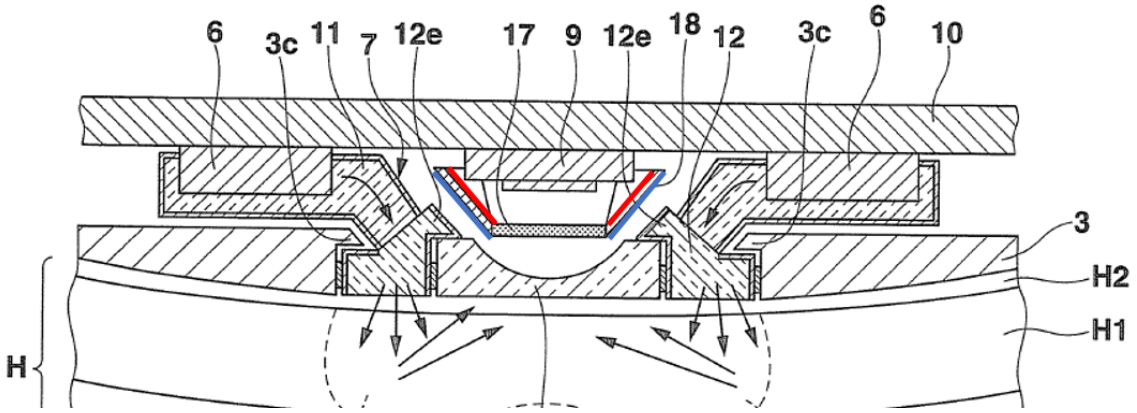
EX1004 at 18:61-65. Iwamiya repeats that teaching throughout the specification. *See id.* at 28:64-29:1, 39:20-24. Iwamiya thus includes a special additional manufacturing step to add a reflective surface to enhance optical protection. And as I also explained previously, a POSITA reading Iwamiya as a whole would understand that Iwamiya's teachings regarding using reflective materials for light

shielding on the holder portion 43 is applicable to the light shielding frame 18, which is analogous to the holder portion 43. *See* EX2002-1291 at ¶¶ 96-98; EX2002-1465 at ¶¶ 75-77.

60. Iwamiya also teaches the use of reflective surfaces for optical isolation on other parts of the sensor as well. For example, Iwamiya teaches that a "first reflection layer 13" and a "second reflection layer 15" are provided by "a metal vapor deposition method." *See* EX1004 at 6:62-7:3, 7:41-49. Iwamiya explains that both the "first reflection layer 13" and "second reflection layer 15" prevent the observation light from "leaking" to the outside of the light guiding ring portion 11 and the diffusion/irradiation ring portion 12, respectively. *Id.* at 6:62-7:3, 7:41-49. A POSITA would have understood from Iwamiya's detailed and repeated descriptions that Iwamiya carefully designed the sensor to consider how best to protect the light receiving unit and specifically chose reflective materials to do so. Apple and Dr. Anthony never address the fact that Iwamiya expressly taught the use of reflective materials for light shielding or explain why a POSITA would have ignored that teaching and proceeded against that teaching.

61. Apple also argued that a POSITA would have been motivated to use Sarantos' in-mold label or mask to "limit[] reflections, which could lead to stray light being incident on the photodiodes 9." 1291 Pet. 16. But Apple and Dr. Anthony did not explain how reflections could somehow lead to stray light being incident on

the light receiving unit in Iwamiya. Apple's and Dr. Anthony's premise does not make sense. A POSITA reviewing Iwamiya would not have recognized that reflections could lead to stray light being incident on the light receiving unit 9 and would not have been motivated to add a dark-colored coating for that reason. First, Apple and Dr. Anthony did not even explain *where* they proposed placing the in-mold label on Iwamiya's light shielding frame. The light shielding frame has an exterior and interior surface, as shown below by the blue and red outlines, respectively.



EX1004 at Fig. 4 (cropped and annotated to show exterior surface of the light shielding frame outlined blue, interior surface outlined red). Apple and Dr. Anthony do not explain whether the in-mold label would be placed on the exterior or interior surface of the light shielding frame. Regardless, neither placement would help limit stray light from reflecting onto the light receiving unit.

62. Placing a dark-colored coating on the exterior of the light shielding frame would not improve the light shielding frame's ability to shield light. A

[redacted]

POSITA would have understood that Iwamiya's light shielding frame reflects light and prevents it from bypassing the optical filter. This allows the light from the measurement site to be redirected towards the optical filter and eventually to the light receiving unit. Placing a dark-colored coating on the exterior would reduce the opportunity for light from the measurement site to be reflected in a way that it passes through the optical filter and eventually to the light receiving unit. A POSITA would have understood that this would degrade or be detrimental to the performance of Iwamiya's sensor.

63. Placing a dark-colored coating on the interior of the light shielding frame also does not improve the light shielding frame's ability to prevent stray light from reaching the light receiving unit. Any light in the interior of the light shielding frame would have needed to pass through Iwamiya's optical filter 17, which is mounted on the light shielding frame. *See* EX1004 at 8:38-42, Fig. 4. Iwamiya explains that the optical filter "shield[s] light of a wavelength band of 900 nm or less, such that the light receiving unit 9 alleviates an influence from a measurement change due to ***external light, such as sunlight.***" EX1004 at 8:42-47. Iwamiya further explains that "the optical filter 17 intercepts light of a wavelength band of less than 900 nm and transmits light of a wavelength band of 900 nm or more, and the light receiving unit 9 alleviates [sic] the influence from the measurement change due to the external light, receives only the light of the specific wavelength band

[redacted]

transmitted through the optical filter 17." *Id.* at 8:48-57. A POSITA would have understood that Iwamiya already prevented unwanted stray light from reaching the light receiving unit by filtering it out. Placing a dark-colored coating on the interior of the light shielding frame would therefore provide no benefit. In fact, a POSITA would have understood that adding a dark-colored coating to the interior of the light shielding frame would be detrimental to Iwamiya's sensor. A POSITA would have understood that a reflective surface would redirect the light, which has already been filtered, towards the light receiving unit so that Iwamiya's sensor can detect a signal. A dark-colored coating on the interior of the light shielding frame would absorb the desired 940 nm light in the interior of the light shielding frame, leading to less of the desired light being incident on the light receiving unit and a reduction in the measured signal. That is contrary to Iwamiya's teachings, which repeatedly discuss a problem with weak signals, and provides a sensor design incorporating reflective materials that addresses the weak signal problem. A POSITA would not have been motivated to use a light-absorbing material when that would decrease the amount of light detected. Because neither placing a dark-colored coating on the exterior or interior surface of the light shielding frame would improve Iwamiya's design which already prevents stray light from reaching the light receiving unit, a POSITA would not have been motivated to add a dark-colored coating.

[redacted]

64. Moreover, Sarantos used an "in-mold label" or "painted or silk-screened mask" to create window regions within a translucent or transparent material. Sarantos explains that in Figure 22, there is a window 2278 "made from a translucent or transparent material, such as transparent acrylic, with an in-mold label 2276 embedded within it" and that the label or mask "may be black or otherwise rendered opaque to light to prevent light from entering or existing the PPG sensor through the window 2278 except through window regions 2226." EX1005 at 17:1-12.

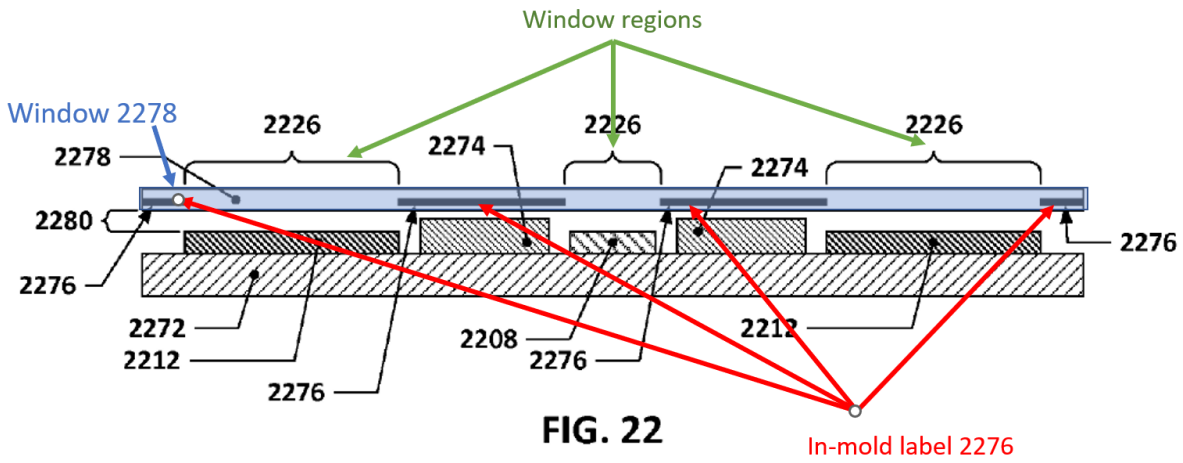


FIG. 22

EX1005 at Fig. 22 (annotated). As shown in the figure, the window 2278 which is translucent or transparent, covers the entire sensor, including the light source 2208 and the photodetectors 2212. Thus, because Sarantos chose to use a translucent/transparent material, Sarantos used the in-mold label or mask to create window regions and block light that would otherwise transmit through the translucent or transparent window where not intended. Sarantos'

[redacted]

translucent/transparent material would not be able to block light without the in-mold label or mask. However, a POSITA would have found no reason to apply that disclosure from Sarantos to Iwamiya's light shielding frame 18 because it is not transparent or translucent. Apple arbitrarily chooses to place a dark-colored coating on the light shielding frame when there is no indication in Sarantos to apply the in-mold label or mask to a non-transparent or non-translucent material. Sarantos' in-mold label or mask would have no purpose relevant to Iwamiya's light shielding frame 18.

65. In view of the above and my original opinions, I believe that a POSITA would not have been motivated to combine Iwamiya's light shielding frame 18 with an in-mold label or mask from Sarantos. *See* EX2002-1291 at ¶¶ 92-101; EX2002-1465 at ¶¶ 71-80. Apple's proposed combination solves no problem with Iwamiya and, instead, relies on an unreasonable assumption that Iwamiya's light shielding frame 18 does not work. Apple's arguments about reducing reflections to limit stray light are also directed to a problem that does not exist in Iwamiya and a POSITA would not have recognized that a dark-colored coating would actually benefit Iwamiya's sensor design. Instead, Apple and Dr. Anthony ignored Iwamiya's explicit teachings to use reflective materials to shield light. A POSITA would not have ignored Iwamiya's explicit teachings to use reflective materials for light shielding and Apple and Dr. Anthony gave no reason for proceeding against

Iwamiya's explicit teachings. In my opinion, the only discernable reason for the combination is hindsight.

D. Claim 15: The Proposed Combination Does Not Disclose a Plurality of Photodiodes "arranged in an array having a spatial configuration corresponding to a shape of the portion of the tissue measurement site encircled by the light block"

66. Claim 15 requires "a plurality of photodiodes … wherein the plurality of photodiodes are arranged in an array having a spatial configuration corresponding to a shape of the portion of the tissue measurement site encircled by the light block." Apple relies on a passage from Iwamiya which states:

> [P]lural light receiving units 9 may be two-dimensionally disposed in the places positioned at the side opposite to the skin H in the scattered light taking unit 8. In this case, the plural light receiving units 9 are preferably disposed on the same circumference centered on an optical axis of the scattered light taking unit 8.

EX1004 at 14:36-41. However, Apple and Dr. Anthony fail to show how that passage discloses the specific arrangement of photodiodes recited in Claim 15. That passage is vague and unclear. Iwamiya does not show the alternative embodiment in any figures. The Petition and Dr. Anthony's declaration simply quote this passage and conclude without additional analysis that "[a] POSITA would thus have understood that the photodiodes described in Iwamiya" are arranged in the claimed arrangement. 1291 Pet. 23-24; EX1003-1291 at ¶ 57. In my opinion, Apple and Dr. Anthony have not shown that Iwamiya discloses limitation [15.4].

[redacted]

67. Limitation [15.4] requires the array to have a "spatial configuration corresponding to a shape of the portion of the tissue measurement site encircled by the light block." Limitation [15.3] specified that the light block has a "circular shape." Thus, the portion of the tissue measurement site encircled by the light block is circular. Masimo explained during prosecution of parent application 15/195,199 that a similarly phrased limitation, "arranged in an array having a spatial configuration corresponding to the shape of the irradiation portion of the tissue measurement site" requires "a sufficient number of detectors such that, when arranged together in an array, can 'match,' 'have a close similarity,' or 'represent' the 'at least partially circular shape' of the irradiated portion of the tissue measurement site." EX2057 at 322. Masimo explained that "two detectors, for example, can only be arranged in a spatial configuration representing a line and three detectors, for example, can only be arranged in a spatial configuration representing a line or a triangle." *Id.* Masimo then gave an example that "six or more detectors could be arranged in an annular shape and meet the recited limitation." *Id.*

68. Apple and Dr. Anthony did not explain how the vague passage in Iwamiya discloses the claimed arrangement. They did not provide any illustration of the proposed combination, nor did they even explain how many photodetectors are involved in the combination, or how they would be sufficient to define the recited arrangement. Iwamiya's passage does not provide those missing details. It does not

[redacted]

explain how many "light receiving units" there are in the alternate embodiment—it just says "plural," which could be as few as two or three. But that would not be sufficient to define a circular shape, as Masimo previously stated in the prosecution history. Iwamiya also does not clearly explain where the "light receiving units" would be placed. Instead, it vaguely describes disposing them on the "same circumference centered on an optical axis of the scattered light taking unit 8." Iwamiya also does not explain how there would be room for multiple light receiving units in its space-constrained design. Indeed, Iwamiya's Figure 4 shows a single light receiving unit surrounded by the light shielding frame 18. It is not clear how multiple light receiving units would be positioned or whether other structures such as the light shielding frame in Iwamiya would be modified or potentially removed altogether. Thus, I disagree with Apple's and Dr. Anthony's conclusion that a POSITA "would have understood that the photodiodes described in Iwamiya" are arranged as claimed. Iwamiya's disclosure is too vague and unclear for a POSITA to understand that it discloses the claimed arrangement. Therefore, in my opinion, Apple has not shown that Claim 15 would have been obvious.

69. Finally, I note that Apple presented an identical argument for Claim 15 in IPR2022-01465. *See* 1465 Pet. 27-28; EX1003-1465 at ¶ 81. My opinions here regarding IPR2022-01291 are equally applicable to IPR2022-01465.

VIII. IPR2022-01291 GROUNDS 2A AND 2B DO NOT ESTABLISH OBVIOUSNESS

70. Ground 2A addresses Claims 1, 9, 15, and 18 based on a combination of Sarantos and Shie. Ground 2B challenges Claims 15, 18, 20, and 27 based on a combination of Sarantos, Shie, and Venkatraman. My original opinions regarding Grounds 2A and 2B are set forth in Exhibit 2002-1291 at ¶¶ 106-131. Below, I present additional opinions that are supplemental to my original opinions expressed in Exhibit 2002-1291.

71. The discussions herein regarding independent Claims 1, 15, and 20 are also applicable to IPR2022-01465.

A. Claims 1, 9, 20, 27: Apple and Dr. Anthony Failed to Analyze "First Shape" and "Second Shape"

72. As I noted in ¶¶ 107-109 of Exhibit 2002-1291, Apple and Dr. Anthony did not explain the "first shape" or "second shape" in their proposed combination of Sarantos and Shie. The Board noted in the Institution Decision that "the claims at issue do not appear to require the identification of a particular shape." Institution Decision at 25. The issue, however, is not whether the claims require naming any particular shape. Rather, as I explained above, the claims require that the first and second shapes (whatever they may be) are ***different*** from each other. However, Apple's Petition and Dr. Anthony's declaration provide no evidence or analysis

showing that the "second shape" is different than the "first shape" in its Sarantos and Shie combination.

73. Apple's and Dr. Anthony's analyses are inconsistent with the level of analysis that Apple demanded in the ITC Investigation to show that a device satisfies the "first shape" and "second shape" limitations. During the ITC investigation, Apple argued that "the relevant comparison is between the shape of the light when it reaches the MLA and the shape of the light when it emerges from the MLA." EX2074 at 65:18-23. I understand that one of the issues in the ITC Investigation was whether this MLA (or "microlens array") in the accused Apple Watches satisfied the "material configured to change a first shape into a second shape" element. I understand that the ITC Initial Determination also agreed that "the relevant 'first shape' is immediately before the MLA, because it is the MLA that must be configured to change the light from the 'first shape' to the 'second shape.'" EX2093 at 188.

74. Given Apple's positions in the ITC about the meaning of "first shape" and "second shape," and the analysis that is required to show that the "first shape" and "second shape" limitations have been satisfied, Apple's Ground 2A and 2B arguments fail to show that their proposed combination of Sarantos and Shie would result in a "second shape" that is different than the "first shape." In fact, as I noted

above, Dr. Anthony's opinions are fundamentally flawed because he apparently believes that the "first shape" and "second shape" can be the same shape.

75. Apple and Dr. Anthony only argue that "Shie describes a diffuser that has a 'light diffusing and shaping advantages' and changes a first shape of light into a second shape." 1291 Pet. 32; EX1003-1291 ¶ 76. But, as I mentioned in my original declaration, Shie does not discuss changing a first shape of light into a second shape. Apple also did not identify any particular "diffuser" from Shie for combination with Sarantos. As I mentioned before, Shie describes over a dozen different optical elements, each with integrated diffusers. *See* EX1007 at Figs. 1a-11, 4:49-:25. Without specifically identifying which of the many optical elements in Shie would be used, it is impossible to even begin to analyze whether there would be a different "first shape" and "second shape." Apple and Dr. Anthony also do not even explain how a POSITA would have even known which optical element to pick or why.

76. The portions of Shie that Apple and Dr. Anthony rely on do not describe a change in the shape of light. Apple's and Dr. Anthony's description of Shie mixes Shie's Abstract with a description in Shie that was discussing multiple different embodiments of cylindrical lenses with integrated diffusers. 1291 Pet. at 30; EX1003 at ¶ 71. They specifically rely on a statement in the Abstract that a "plurality of surface micro-structures are integral in a portion of the optical element.

The micro-structures are designed to homogenize light passing through the optical element to produce a predetermined pattern of smoothly varying, non-discontinuous light exiting the optical element." *Id.*; EX1007 at Abstract. But a POSITA would have understood that the references to "homogenize light passing through" and "smoothly varying, non-discontinuous light" are referring to diffusing light. But simply diffusing light is not necessarily a change in shape, as I explained in my original declaration. EX2002-1291 at ¶ 46. It is also unclear what Shie meant by "shaping advantages" in the portion of Shie that Apple relied upon, and in particular, whether that would result in a change between the shape of light at the entrance to the optical element and the shape of light at the exit of the optical element. EX1007 at 6:61-7:7.

77. In sum, Apple's Petition and Dr. Anthony's declaration fail to analyze the "first shape" and "second shape" limitations, and in particular, fail to show that the "second shape" would be different than the "first shape." Apple and Dr. Anthony also do not set forth an adequately detailed proposed combination of Sarantos and Shie from which it would even be possible to evaluate whether the "first shape" and "second shape" would be different. Apple's mere reliance on the phrase "light diffusing and shaping advantages" is not sufficient to meet the limitation, given the history of this claim term, both in the prosecution history and as further developed in the ITC Investigation.

B. All Challenged Claims: Apple Fails to Demonstrate that a POSITA Would Have Been Motivated to Combine Sarantos with Shie

78. Apple presented three arguments why a POSITA supposedly would have been motivated to combine Sarantos and Shie: (1) "to precisely direct the light emitted toward the tissue so as to increase power efficiency by shining light closer to photodiodes, as light not incident on the photodiodes represents wasted power," (2) "increase accuracy of measurements by directing light towards a larger area to decrease irregular readings caused by moles or other aberrations on the skin," and (3) "to obscure the LED's appearance from a user." 1291 Pet. at 32. Apple and Dr. Anthony claimed that "light shape changing materials were known to be used for such purposes in the prior art," but they did not cite even a single prior art reference, or any other evidence for that matter, showing that light shape changing materials were used for any of the three alleged purposes. *See id.*; EX1003-1291 ¶ 76.[2] Nor did they cite any evidence suggesting that the combination would actually "increase power efficiency" or "increase accuracy of measurements" as they speculated.

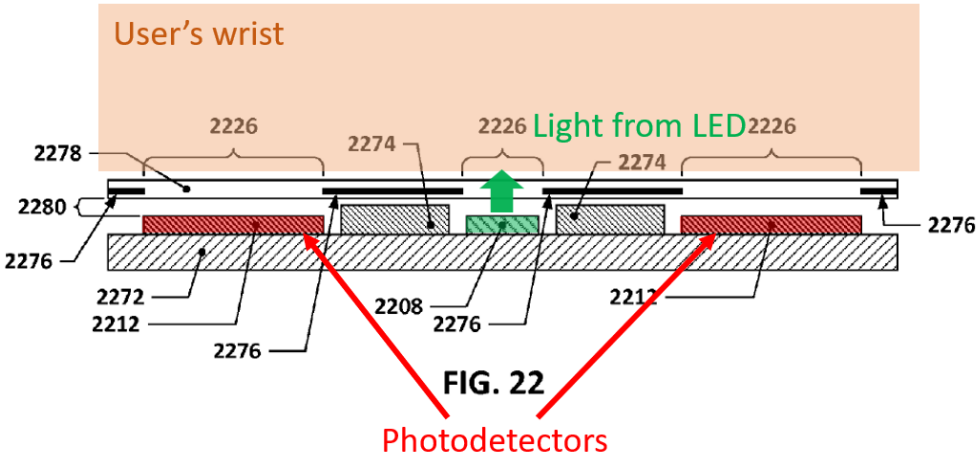
[2] Dr. Anthony's declaration contains a citation to "Id. ¶¶ 400, 418, 425-28." That citation is not a citation to any evidence in this IPR. *See* EX2002-1291 ¶ 119. Dr. Anthony also admitted in his deposition that this citation was a "mistake." EX2071 at 190:13-194:15.

79. I do not believe that a POSITA would have been motivated to combine Sarantos and Shie without any sort of contemporaneous evidence supporting the three motivations. As I mentioned before, there is no discernable reason why a POSITA would have been motivated to combine Sarantos and Shie prior to the '745 Patent's priority date. Sarantos does not discuss placing an optical material that would change the shape of light between the LED and the user's skin. And Shie is a completely unrelated reference—it has nothing to do with physiological monitoring. It is simply a patent that describes several types of diffusers from a company that makes optical materials. There is no disclosure in Shie that would have suggested to a POSITA that something in Shie might be useful for a PPG sensor. Apple did not present any evidence that a POSITA would have known which of the many optical elements disclosed in Shie to combine with Sarantos or that any such selection would benefit Sarantos' unique sensor design. Without any contemporaneous evidence supporting the three alleged motivations, Apple and Dr. Anthony appear to simply have looked for a reference that discusses diffusers and then came up with *post hoc* reasons to combine them that a POSITA would not have known about or thought of at the time of the '745 Patent.

80. Apple's first alleged motivation was to "precisely direct the light emitted toward the tissue so as to increase power efficiency by shining light closer to photodiodes, as light not incident on the photodiodes represents wasted power."

[redacted]

1291 Pet. 32. But "direct[ing] the light emitted toward the tissue" to try to "increase power efficiency" makes no sense in the context of Sarantos' sensor design. In Sarantos' sensor design, the LED is already placed right next to the tissue.



EX1005 at Fig. 22 (annotated). There is no need to further "direct" the light when the LED is placed right against the tissue. All the light from the LED is already being directed straight into the user's tissue.

81. Moreover, a POSITA would not have thought that Sarantos needed to further "direct" the light because Sarantos specifically designed the high aspect ratio (HAR) photodetectors to capture nearly all of the light signal based on how light is emitted by the LED and scattered by the user's tissue. Sarantos provided empirically derived light intensity plots, shown in Figures 4 and 5, of how much light that is shined into a person's arm is emanated back out. *See* EX1005 at 8:39-58, 10:27-50, Figs. 4-5. Sarantos teaches that the benefit of the HAR photodetectors is that, due to its rectangular shape, the HAR photodetector highlighted in Figure 5 is able to

[redacted]

collect "nearly 85% of the available AC power," which is "nearly four times as much light" as would be collected by a square photodetector highlighted in Figure 4. EX1005 at 10:27-36.

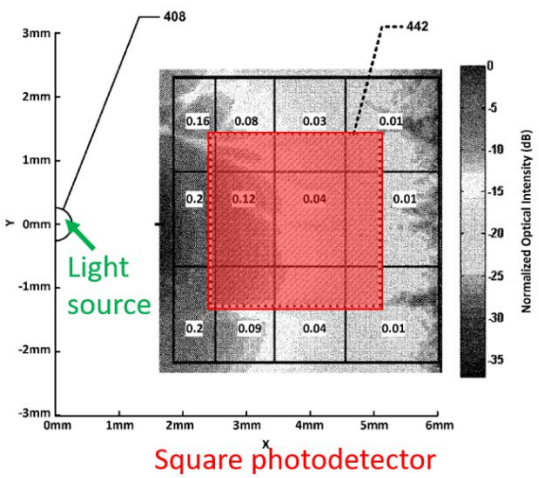


FIG. 4

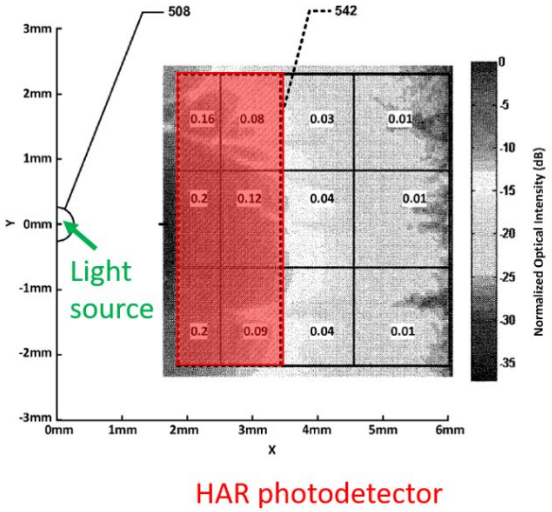


FIG. 5

EX1005 at Figs. 4-5 (annotated). As further shown in Sarantos' Figure 6, the improved light detection relies on the rectangular HAR photodetector overlapping as much as possible with the relatively thin ring of high intensity reflected light surrounding the light source.

[redacted]

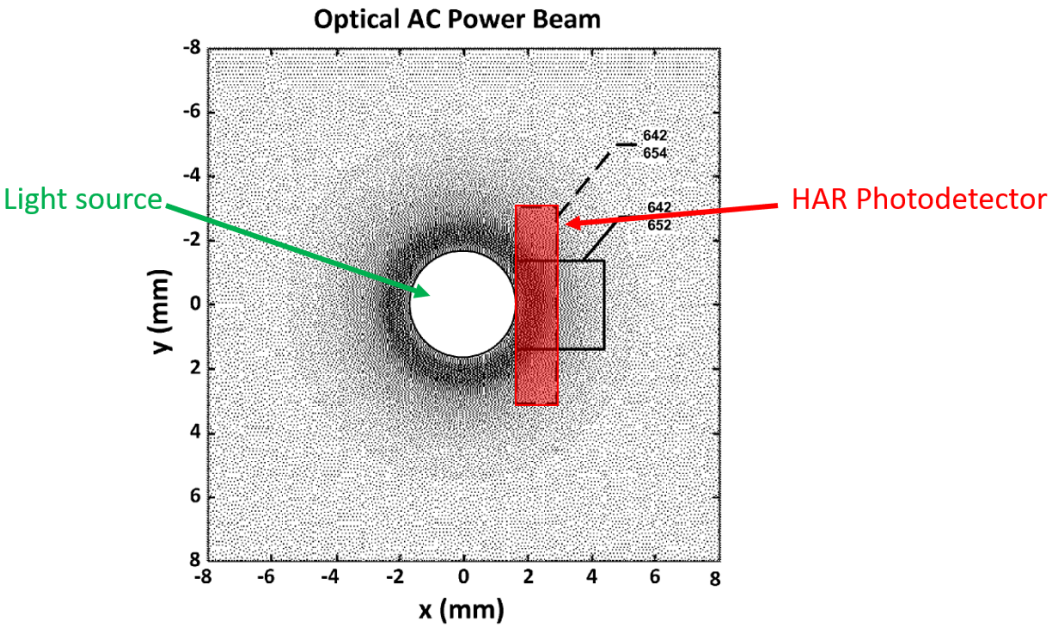


FIG. 6

Id. at Fig. 6 (annotated), 8:39-11:3. A POSITA would have understood that the HAR photodectors in Sarantos were specifically tailored to capture as much of the light as possible based on Sarantos' empirical studies shown, for example, in Figures 4-6. Not only would there not have been a need to further direct light, but adding a diffuser or material to change the shape of the light would negate Sarantos' design which captures "nearly 85% of the available AC power in the overall area." EX1005 at 10:30-34. And as I explained below and in my original declaration, adding a diffuser would decrease the amount of light transmitted to the tissue and therefore reduce the light signal. *See* EX2002-1291 at ¶ 113; EX2002-1465 at ¶ 103. A POSITA would have understood that Apple's proposed combination would require larger and wider detectors to capture the reflected light signal, which is contrary to Sarantos' design.

82. Apple also did not even explain what it even meant by directing the light toward the tissue to shine light closer to the photodiodes. Apple did not provide any clear explanation of how that would be accomplished in Sarantos' sensor design. Apple did not identify any optical material from Shie that could perform that function. Nor did Apple explain how a POSITA would have known how to choose such an optical element. As I mentioned previously, Apple's asserted level of ordinary skill in the art does not specify any particular knowledge of optics. And as I explained previously, Apple's suggestion that its combination would "precisely direct the light" is inconsistent with Apple's second motivation which is to "direct[] light towards a larger area." Precisely directing light and directing light towards a larger (and therefore, less precise) area, describe opposite results.

83. Apple also provided no explanation why a POSITA would have even thought to use some optical material from Shie to try to shine light closer to the photodiodes. If a POSITA wanted to change the LED-photodiode distance, they would have done that by physically placing the LED and photodiodes closer together. Indeed, Sarantos already identified a range of "typically 1 mm to 4 mm apart" for the LED-photodetector spacing that would provide a "sufficiently strong signal." EX1005 at 18:61-66, 19:13-18; EX2002-1291 at ¶ 114. Given this disclosure in Sarantos, Apple and Dr. Anthony fail to explain why a POSITA would have thought of using an optical material to accomplish shining light closer to the

photodiodes. That is not taught in Sarantos or Shie and Apple identified no evidence suggesting that this would have been known or that it would have even worked.

84. In fact, a POSITA would not have been motivated to try to shine light even closer to the photodiodes than the 1 mm minimum distance that Sarantos specified. A POSITA would have known that the appropriate distance between an LED and a photodiode is in a type of Goldilocks zone—too far and the photodiode would not receive sufficient light, but too close and the photodiode would be saturated with bright light that has not been absorbed by the tissue. Webster describes this very problem: "If we place the photodiode too close to the LEDs, the photodiode will be saturated as a result of the large DC component obtained by the multiple scattering of the incident photons by the blood-free stratum corneum and epidermal layers in the skin." EX1013 at 88-89. The stratum corneum is the top layer of the skin. Saturating a photodiode means that the photodiode would be overwhelmed with light brighter than it can accurately measure. Additionally, a PPG signal is comprised of both AC and DC components, representing the absorption of light due to pulsatile components of arterial blood and the absorption of light due to nonpulsatile components like venous blood or other tissue, respectively. *See* EX1013 at 46-47 (describing the AC and DC components of a PPG signal). It is the AC components, which represent absorption by the pulsatile arterial blood, which are of interest in determining oxygen saturation. *See id.* Webster's explanation that

the photodiodes would be saturated by a "large DC component" means that the photodiodes would be saturated with bright light that would hinder a successful oxygen saturation measurement.

85. Apple's suggestion to use a diffuser to increase power efficiency also does not make sense. As I originally explained, placing a diffuser in front of an LED would cause transmission losses, leading to a decrease in power efficiency, not any increase in power efficiency. EX2002-1291 at ¶ 113. But in addition to transmission loss, a diffuser can spread light over a larger area. Indeed, Apple's second alleged motivation to combine was to direct light to a "larger area." But spreading light over a larger area reduces the local intensity of the light—less light is available to penetrate into the tissue and be scattered back. In other words, the LEDs would need to be driven at a higher power to compensate for the loss in brightness due to transmission losses and spreading the light out. Ultimately, Apple's alleged motivation to combine an unidentified optical material from Shie with Sarantos to increase power efficiency by shining light closer to photodiodes is not supported by any evidence and does not make sense.

86. Apple also argued that its combination would "increase accuracy of measurements by directing light towards a larger area to decrease irregular readings caused by moles or other aberrations on the skin." Pet. 32; *see also* EX1003-1291 ¶ 76. However, as I noted in my prior declarations, Apple and Dr. Anthony cited no

evidence to support this alleged motivation. For example, they cited nothing identifying a problem with irregular readings caused by moles or other aberrations on the skin. Even if a POSITA had known of such a problem, Apple presented no evidence that a POSITA would have been motivated to use some diffuser from Shie as a way to address the problem. There is nothing from Sarantos or Shie discussing the use of a material that changes the shape of light to address this problem. I do not believe that a POSITA, without the benefit of the '745 Patent, would have been motivated to combine Sarantos and Shie based on some desire to address moles or skin aberrations at the time of the '745 Patent.

87. Finally, Apple's last motivation was to "obscure the LED's appearance from a user." Pet. 32; EX1003-1291 at ¶ 76. As I explained in my previous declarations, Apple cited no support for this motivation and it does not make sense because the LED in Sarantos' sensor is normally hidden from the user's view. Apple's alleged motivation is purely cosmetic and, as I explained before, would decrease power efficiency due to transmission losses. *See* EX2002-1291 ¶¶ 113, 118; EX2002-1465 ¶¶ 103, 108. A POSITA would not have been motivated to modify Sarantos to obscure the LED's appearance from a user.

C. Claims 9, 18: Apple Fails to Show that a POSITA Would Have Combined Sarantos and Shie to Measure Oxygen Saturation at the Wrist with a Reasonable Expectation of Success

88. Claims 9 and 18 require oxygen saturation measurements at the wrist. In my original declaration, I explained that Apple had not shown that measuring oxygen saturation at the wrist would have been obvious based on its reliance on Sarantos. Sarantos does not actually disclose a device that is capable of measuring oxygen saturation at the wrist. EX2002-1291 at ¶¶ 81, 120. As I explained originally, a POSITA would have understood that Sarantos' disclosure is aspirational and that a POSITA would have needed to figure out for themselves how to measure oxygen saturation at the wrist.

89. Additionally, as I explained above, the testimony of Apple's engineers and its own internal documents shows objective indicia of nonobviousness, including their skepticism for measuring oxygen saturation at the wrist, failure of others (including Apple and Mannheimer's "other clients") and long-felt but unmet need. That evidence also demonstrates that a POSITA would not have reasonably expected success in taking Sarantos' mention of red and infrared light and making a device that can measure oxygen saturation at the wrist as of July 2015. Thus, in my opinion, Claims 9 and 18, which require oxygen saturation measurements at the wrist, would not have been obvious.

IX. IPR2022-01465 GROUNDS 1A AND 1B DO NOT ESTABLISH OBVIOUSNESS

90. Grounds 1A and 1B in IPR2022-01465 challenge dependent claims of the ’745 Patent that were not addressed in IPR2022-01291. The 1465 Petition repeats the same arguments for the independent Claims 1, 15, and 20 that were presented in Grounds 1A and 1B in IPR2022-01291. My opinions regarding Apple’s obviousness arguments for Claims 1, 15, and 20 in Grounds 1A and 1B of IPR2022-01465 are the same as described in my original declaration, EX2002-1465, and as also supplemented above with respect to Grounds 1A and 1B of IPR2022-01291. Because, in my opinion, Apple did not establish obviousness of the independent claims, Apple also has not established obviousness of any of the dependent claims addressed in Grounds 1A and 1B.

A. Claims 2-6, 8, 10-12, 14, 21-26: A POSITA Would Not Have Been Motivated, Except by Hindsight, to Add a “surface comprising a dark-colored coating” to Iwamiya

91. Like in IPR2022-01291, Apple argues in IPR2022-01465 that a POSITA would have combined Iwamiya and Sarantos to add a dark-colored coating to Iwamiya’s light shielding frame 18 for Claims 1 and 20. 1465 Pet. at 13-16, 31. As I discussed above and in my original declaration, a POSITA would not have had a motivation to do so. *See supra* Section VII.C.; *see also* EX2002-1465 at ¶¶ 71-80. Thus, in my opinion, Apple has not shown that Claims 2-6, 8, 10-12, 14, and 21-26, which depend from either Claims 1 or 20, would have been obvious.

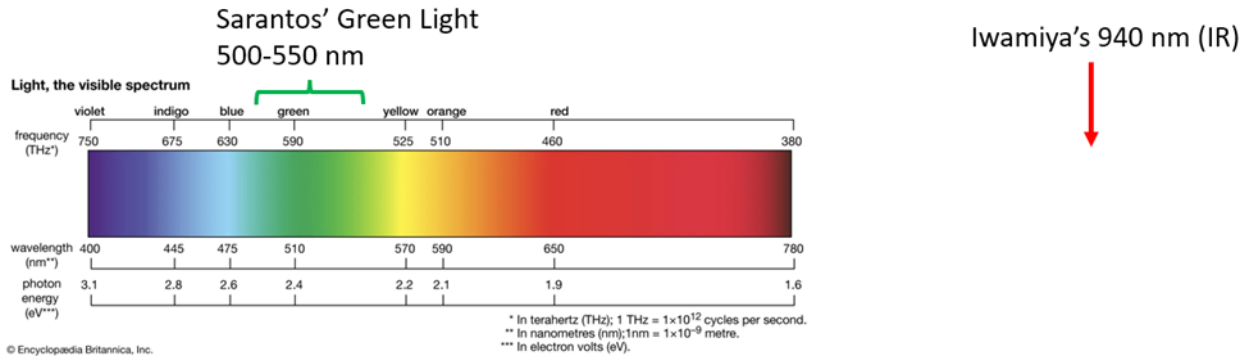
[redacted]

B. Claim 2: A POSITA Would Not Have Combined Iwamiya with Sarantos to Add a "Second Wavelength"

92. In my original declaration, I explained why a POSITA would not have combined Iwamiya with Sarantos to add a second wavelength. *See* EX2002-1465 at ¶¶ 88-91. I explained, for example, that a POSITA would not have had a reasonable expectation of expanding Iwamiya's physiological measurements to include additional types of measurements, namely, oxygen saturation. *Id.* at ¶ 91. As discussed above, I have reviewed the documents that Apple produced from the ITC Investigation and they confirm that a POSITA would not have had a reasonable expectation of success for measuring oxygen saturation at the wrist as of the '745 Patent priority date.

93. Additionally, I further believe that a POSITA would not have been motivated to combine Iwamiya with Sarantos because Iwamiya taught away from using the wavelengths that are the focus of Sarantos' disclosure. As I explained above, Iwamiya chose infrared light at 940 nm to avoid a problem where light at lower wavelengths would be absorbed by melanin in the skin, resulting in weak signals such that "biological information, such as a pulse wave, cannot be detected." EX1004 at 1:62-2:6, 21:38-22:12; EX2002-1465 ¶ 89. As I annotated in the graphic below, Iwamiya's 940 nm light is very different than green or red light:

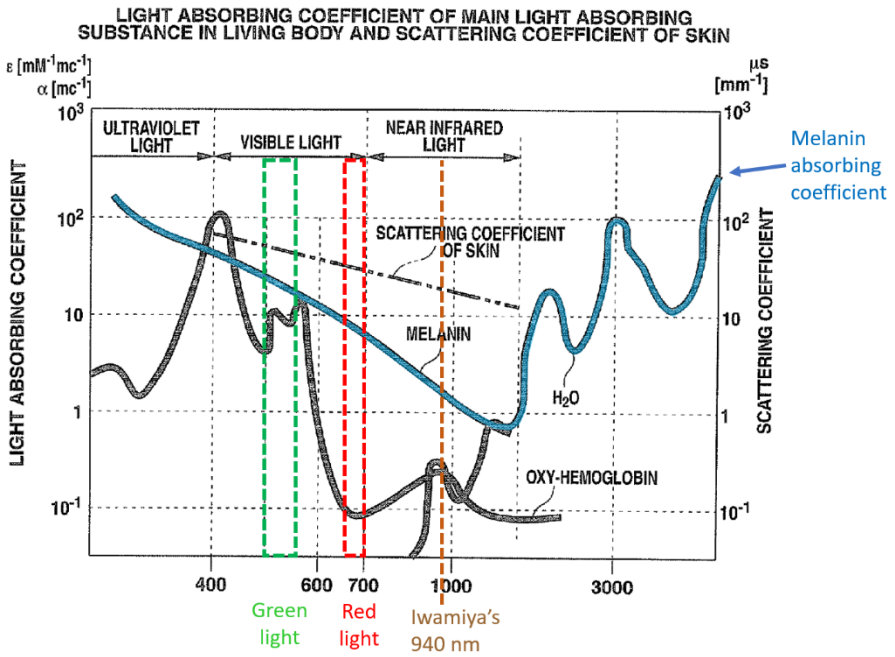
[redacted]



2073 (annotated).

94. Iwamiya explained that melanin pigment in the skin "has extraordinarily high absorbance in a wavelength band from ultraviolet light to visible light." EX1004 at 1:62-64. Thus, Iwamiya taught away from using UV or visible light. Iwamiya also specifically criticized the use of wavelengths at or below 600 nm. *Id.* at 1:64-2:6. Iwamiya repeatedly explains throughout its disclosure that the use of 940 nm light is to avoid the melanin absorption problem. *See* EX1004 at 6:31-34, 10:34-38, 11:43-49, 15:26-29, 20:51-55, 21:62-67, 22:24-31, 32:57-60, 42:44-48, 44:15-20. Iwamiya also goes to great lengths to avoid light below 900 nm, which includes UV and visible light, and dedicates substantial disclosure to teaching against light other than 940 nm. For example, Iwamiya's Figure 6 illustrates the melanin absorption problem with UV and visible light as compared with Iwamiya's 940 nm light.:

[redacted]



EX1004 at Fig. 6 (annotated); *see also id.* at 1:62-2:6. In Iwamiya's Figure 6, annotated above, the melanin absorption coefficient (highlighted blue) is shown on a logarithmic scale. The figure shows that the absorption coefficient for green light (green box) is approximately 20 times higher than at 940 nm (brown line) and approximately eight times higher in the red spectrum (red box) than at 940 nm.

95. Iwamiya also explains that its light receiving unit has a peak sensitivity to light at 940 nm and significantly less sensitivity for other wavelengths. EX1004 at 8:29-37, Fig. 9 (annotated below). As shown in Figure 9, the relative sensitivity of the light receiving unit at Sarantos' 500-550 nm (green box) is only between 15-25% of the peak sensitivity at Iwamiya's 940 nm (brown line), and the relative sensitivity for red wavelengths 660-700 nm (red box) is only around 50-60% of the peak sensitivity at 940 nm. Thus, Iwamiya's sensor has very little sensitivity to

[redacted]

measurements of light in the visible spectrum and was not designed for taking such measurements.

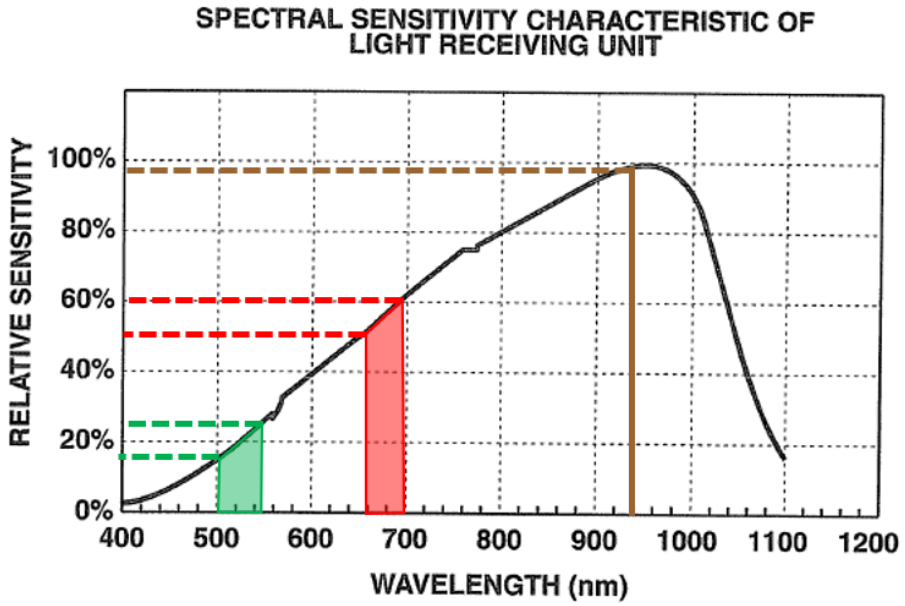


FIG.9

96. Because Iwamiya taught against using other wavelengths besides 940 nm, Iwamiya includes a filter which only transmits light above 900 nm and filters out light below 900 nm. *Id.* at 8:38-47. Apple's proposed combination specifically relies on that filter for limitation [1.5]. *See* 1465 Pet. at 16-17. Iwamiya's Figure 8 shows that its filter has 0% transmittance for visible light, including for Sarantos' green (500-550 nm) wavelength, as well as for red (660-700 nm) and some infrared wavelengths (<approximately 850 nm). This means that no visible light, including green and red, would be able to pass through the filter.

[redacted]

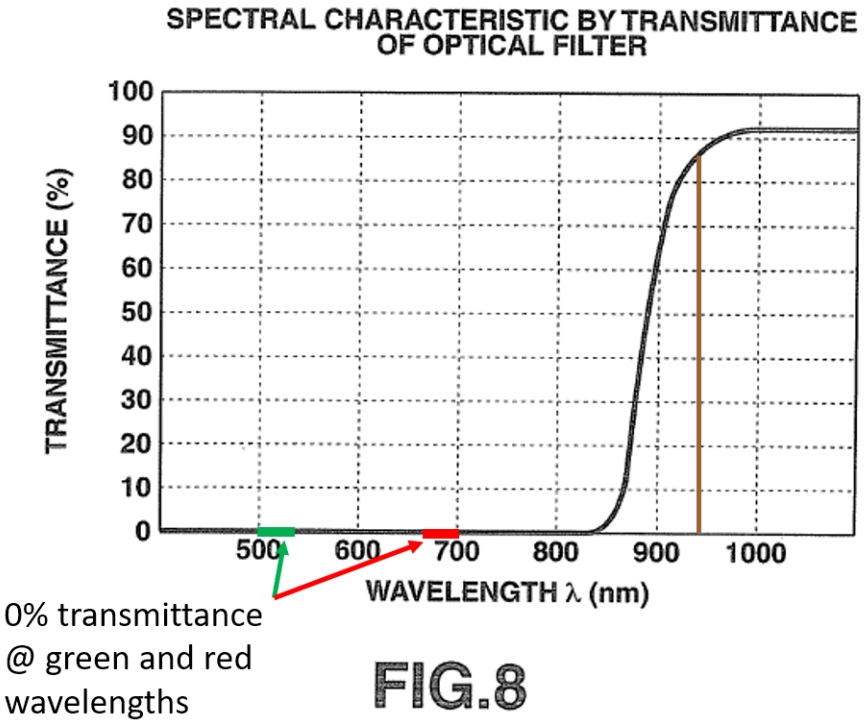


FIG.8

EX1004 at Fig. 8 (annotated).

97. In contrast, Sarantos is focused on using light below 600 nm, as I explained previously. EX1005 at 18:35-51 (explaining that Sarantos' disclosure was discussed primarily with respect to 500-550 nm green light and may see similar performance with light up to 600 nm, but was not tailored to the red or infrared spectra); *see* EX2002-1465 at ¶ 91. A POSITA would not have been motivated to combine Iwamiya and Sarantos because Iwamiya taught against using the wavelengths that Sarantos' disclosure focused on.

98. Additionally, Apple's proposed combination would be inoperable. Iwamiya's optical filter would filter out all visible light mentioned in Sarantos, including green, yellow, orange, and red light because they are below 900 nm.

Sarantos' brief mention of infrared light does not supply a second wavelength because Iwamiya already uses infrared light at 940 nm.

99. Thus, in my opinion, a POSITA would not have been motivated to combine Iwamiya and Sarantos to add a second wavelength because Iwamiya's optical filter would render the combination inoperable, Iwamiya taught away from using Sarantos' disclosed wavelengths, and a POSITA would not have had a reasonable expectation of success in adding oxygen saturation measurements to Iwamiya's device.

C. Claims 6, 17, 19, and 26: Iwamiya Does Not Disclose "wherein the plurality of photodiodes are arranged in an array having a spatial configuration corresponding to a shape of a portion of the tissue bounded by the light block"

100. Claim 6 recites "The physiological monitoring device of claim 1, wherein the plurality of photodiodes are arranged in an array having a spatial configuration corresponding to a shape of a portion of the tissue bounded by the light block." Claim 26 similarly recites "The system of claim 20, wherein the plurality of photodiodes are arranged in an array having a spatial configuration corresponding to a shape of a portion of the tissue encircled by the light block." These limitations are analogous to the same limitation in Claim 15. As I explained in my original declaration and above in Section VII.D, Apple has not shown that its proposed combination discloses Claim 15's requirement of "wherein the plurality of photodiodes are arranged in an array having a spatial configuration corresponding

[redacted]

to a shape of a portion of the tissue bounded by the light block." *See supra* Section VII.D.; EX2002-1465 at ¶¶ 81-87. In my opinion, Apple has not shown that these claims would have been obvious because Iwamiya does not disclose a plurality of photodiodes that are arranged in the claimed manner. A POSITA also would not have interpreted or been motivated to modify Iwamiya to include a plurality of photodiodes in an annular or ring-shaped arrangement because that would leave an empty region in the center with no light detection.

101. Apple argues that "By disposing the plural light receiving units 9 in an annular or ring-shaped arrangement around the circumference, the plural light receiving units 9 are thereby arranged in a spatial configuration corresponding to the annular or ring-shaped portion of the tissue bounded by the reflection layers of the annular light guide 7." Pet. 20; EX1003-1465 ¶ 59. However, Iwamiya does not disclose arranging the light receiving units 9 in an annular or ring-shaped arrangement. Apple quoted a passage from Iwamiya stating that "plural light receiving units 9 may be two-dimensionally disposed in the places positioned at the side opposite to the skin H in the scattered light taking unit 8" and "the plural light receiving units 9 are preferably disposed on the same circumference centered on an optical axis of the scattered light taking unit 8." 1465 Pet. 20 (citing EX1004 at 14:32-41). But that passage does not describe an annular or ring-shaped arrangement of photodiodes. It also does not explain how many photodiodes there

[redacted]

would be. As I explained previously, Iwamiya's disclosure could be referring to as few as two or three photodiodes, which would not satisfy Claim 15. It also would not satisfy Claims 6 or 26 because Apple argued that the relevant light block has a circular shape.

102. Moreover, a POSITA would not have interpreted Iwamiya to disclose such an arrangement or have been motivated to modify Iwamiya to make that arrangement. A POSITA would have understood that Apple's proposed arrangement of photodiodes in an annular or ring-shaped arrangement does not make sense in the context of Iwamiya's sensor design. Iwamiya has a sensor design where there is a photodiode in the center and light emitters on the outer periphery. That is in contrast to other sensor designs, like the ones shown in Sarantos, where there is a light emitter in the center and photodiodes on the outer periphery. An arrangement of photodiodes in an annular or ring-shaped arrangement around the LED would make sense in a sensor design where the LED is in the center because the light emitted in the center would scatter around the LED. But in Iwamiya, where the photodiode is located in the center of an annular light guide, arranging multiple photodiodes in an annular arrangement within the annular light guide makes no sense.

103. A POSITA would have recognized that in Iwamiya's sensor design (annotated below), the scattered light taking unit 8 (which is a concave lens placed

[redacted]

directly under the optical filter and light receiving unit) works to direct light towards the center where the light receiving unit 9 is located.

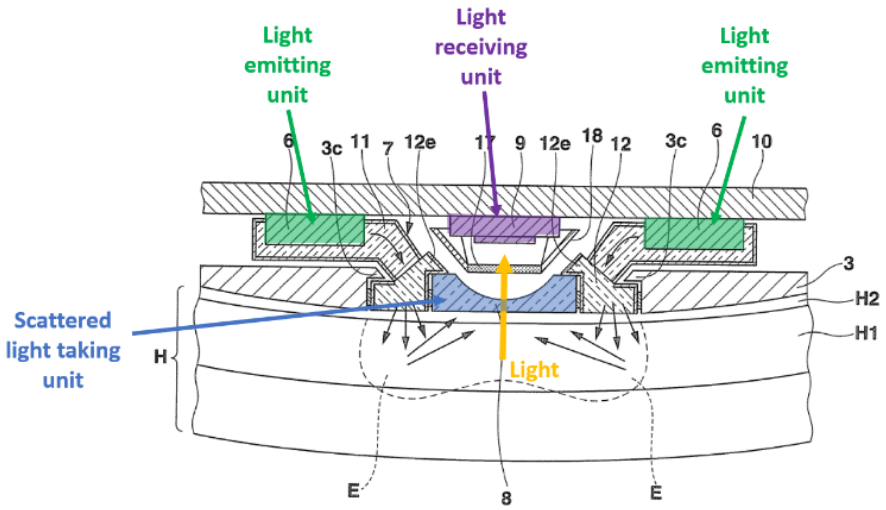


FIG.4

104. A POSITA would have understood that replacing the single light receiving unit 9 with an annular or ring-shaped arrangement of photodiodes would not make sense because that would leave an empty region in the center of that arrangement without photodetector coverage. That would degrade the optical signal because a significant portion of the light that has been attenuated by the tissue and has been directed by the concave lens of the scattered light taking unit 8 to the light receiving unit 9 would not be incident on a photodetector and would not be detected. There is no reason for a POSITA to leave an empty region in the middle which would reduce the amount of detected light, particularly where reflectance sensors are known to produce weaker signals in general and Iwamiya went to great lengths to

[redacted]

address a concern with weak signals. Indeed, Iwamiya employed multiple techniques to address weak signals, including using 940 nm light instead of light under 600 nm, using a light shielding frame, and using an optical filter to filter out light below 900 nm before it reaches the light receiving unit. *See* EX1004 at 1:53-2:6, 8:29-57, 11:43-54, 13:1-11.

X. IPR2022-01465 GROUNDS 2A, 2B, AND 2C DO NOT ESTABLISH OBVIOUSNESS OF ANY CLAIM

105. Apple argued in Ground 2A that Claims 2, 5, 6, 8, 10, 11, 13-14, 17, and 19 would have been obvious based on a combination of Sarantos and Shie. Apple argued in Ground 2B that Claims 3-4, 17, 19, and 21-26 would have been obvious based on a combination of Sarantos, Shie, and Venkatraman. Apple argued in Ground 2C that Claim 12 would have been obvious based on a combination of Sarantos, Shie, and Savant.

A. Apple Fails to Show that Independent Claims 1, 15, and 20 Would Have Been Obvious, and Therefore Fails to Show that Any Dependent Claims Would Have Been Obvious

106. My opinions about Apple's Ground 2A and 2B arguments for independent Claims 1, 15, and 20 are set forth in my original declaration, EX2002-1465, at paragraphs 96-109, and 120-130. My opinions are also supplemented by the additional discussion of Sarantos and Shie set forth in this declaration with respect to IPR2022-01291, above. For the reasons I have already expressed in my original declaration and in this declaration, Apple has not shown that any of the

independent claims would have been obvious under Apple's Grounds 2A, 2B, or 2C. Additionally, because all of the challenged claims in IPR2022-01465 depend from Claims 1, 15, or 20, I do not believe that Apple has shown that any dependent claim would have been obvious.

B. Apple Failed to Show that Claim 19 Would Have Been Obvious for the Same Reasons as Claim 1

107. Unlike Claims 1 and 20, independent Claim 15 does not have the "first shape" and "second shape" limitations. Instead, Claim 15 requires "a light diffusing material" that is positioned between the LEDs and the user's wrist. Dependent Claim 19 adds the limitation, "wherein the plurality of light-emitting diodes are configured to emit light in a first shape, and wherein the light diffusing material is configured to change the first shape into a second shape by which the light emitted from one or more of the plurality of light-emitting diodes is projected towards the tissue measurement site." *See* EX1001 at Claim 19. Apple's arguments for Claim 19 simply refer back to its Claim 1 arguments. *See* 1465 Pet. at 56. For the same reasons as I explained for Claim 1, Apple failed to show that Claim 19 would have been obvious.

C. Claims 12, 25: Apple Uses Hindsight to Argue for Specific Second Shapes

108. Claims 12 and 25 depend from Claims 1 and 20, respectively, both of which have the "first shape" and "second shape" limitations. Claim 12 requires

"wherein the second shape comprises a circular geometry" and Claim 25 requires "wherein the second shape comprises a width and a length, wherein the width is different from the length." As set forth in my original declaration, EX2002-1465, at paragraphs 110-119, I believe that Apple and Dr. Anthony failed to demonstrate that Claims 12 and 25 would have been obvious. In my opinion, these claims would not have been obvious in view of Apple's proposed combination of references. Below, I provide additional opinions regarding these claims. Claim 25 is addressed first because it appears first in Apple's Petition.

1. Claim 25

109. Apple argued that combining Sarantos with a cylindrical lens element from Shie would "change[] light that enters the lens from a first shape to a second shape having a length different from its width, due at least in part to the lens's spreading in the length dimension without corresponding spreading in the width dimension." 1465 Pet. at 67. However, it is not clear from Apple's evidence and arguments that the proposed combination would actually result in a change in a "first shape" to a different "second shape" within the meaning of the '745 Patent.

110. First, Apple did not set forth a clear explanation of the proposed combination for Claim 25. Apple relied on several passages from Shie that describe different cylindrical lenses. Specifically, Apple quoted one passage (1:15-23) in which Shie discussed a conventional cylindrical lens, but then cited Figures 2a and

2b and another passage (6:44-64) that describe a different cylindrical lens with an integrated diffuser. But Apple never clarified which of these different lenses would supposedly be combined with Sarantos or how. For example, Apple does not explain (1) how exactly would the lens be positioned within Sarantos' device, including where and how would the lens be positioned relative to the LED and the user's skin, (2) whether the lens was meant to replace the window region that Sarantos created with the in-mold label or whether the lens is intended to be placed somewhere else, or (3) the direction that the convex side of the lens be facing—towards the LED or towards the skin. This is information that would be critical to understand how the light would be affected by the lens. Without that clarification of which optical material would be combined with Sarantos and how it would be combined, it is impossible to even begin to evaluate whether the combination would satisfy the claim limitations, in particular, whether it would result in a "second shape" different than the "first shape."

111. Second, as noted above, Apple, at the ITC, asserted that the correct analysis for determining whether a device satisfies the "second shape" limitation requires a comparison of the shapes of light before and after the "material." In other words, in this hypothetical combination of Sarantos with a cylindrical lens from Shie, Apple needed to show that the shape of light at the exit from the cylindrical lens is different than the shape of light that is incident on the cylindrical lens. Even

[redacted]

though in the Investigation, the ITC applied Apple's proffered analysis, Apple did not present any such analysis in its Petition.

112. Instead, Apple relied on passage in Shie describing "a conventional cylindrical lens where a beam of light entering the lens remains unaffected in its width and is spread by the cylindrical lens contour in a direction perpendicular to its width." EX1007 at 1:15-23; 1465 Pet. at 67; EX1003-1465 ¶ 201. However, a POSITA would have understood that disclosure is referring to how the light would be spread by the cylindrical lens as it is projected at a distance away from the lens. It does not explain how the light would appear after passing through the cylindrical lens, which would be the relevant analysis for comparing "second shape" with "first shape." How light appears after passing through a lens depends on many factors, including but not limited to the shape of the lens itself, the distance between the light source and the lens, the focal length of the lens, and where the image is being evaluated. Other properties of the lens or the setup also affect the light. For example, Shie describes cylindrical lenses that have an integrated diffuser. Without more information, it is not clear how light would interact with that type of lens. And it is not clear at all how from the limited information presented in the Petition and in Dr. Anthony's declaration how the light would appear in the proposed combination. In particular, I do not believe that using a cylindrical lens in Sarantos would necessarily result in a different shape of light exiting the lens. Whatever the cylindrical lens

[redacted]

does to light at the focal distance does not show how the shape of light would appear at the exit of the cylindrical lens and as on the user's skin because the skin would be right next to the lens. Additionally, the light may not actually change shape because in a lens, light only refracts (changes direction) when it meets a boundary between two indices of refraction (e.g., the boundary between the lens and the user's skin). Thus, it is not clear that the combination would result in a change in the shape of light. Apple also cited Figs. 2a and 2b and 6:44-64 from Shie, but as noted above, those disclosures refer to different cylindrical lenses than the one described at 1:15-23. Those disclosures also do not explain how the shape of light would appear after emerging from the lens. Accordingly, Apple has not shown that its proposed combination would result in a "second shape" that is different from the "first shape" as required by the base independent Claim 20 or that it would result in a "second shape" with a different length and width as required by Claim 25.

113. I also do not believe that Apple and Dr. Anthony have shown that a POSITA would have been motivated to combine Sarantos with a cylindrical lens from Shie. As noted in my original declaration, Apple and Dr. Anthony presented a number of alleged reasons to implement a cylindrical lens into Sarantos. *See* EX2002-1465 ¶¶ 111-115; 1465 Pet. at 68-69; EX1003-1465 ¶¶ 202-204. For example, they argue that this could "better project light towards portions of the wrist tissue nearest the high-aspect ratio (HAR) photodiodes," that "the photodiodes

[redacted]

would capture more of the light signal," that it would "better produce more reliable measurement information without requiring overly expensive, highly-sensitive detector elements," and that it would be advantageous when the photodiodes are "positioned opposite each other on opposite sides of the sensor." 1465 Pet. at 68. The problem, however, as I noted originally, is that none of those reasons is supported by any prior art or other contemporaneous evidence. Left unexplained is how a POSITA would have known of these reasons at or before the time of the '745 Patent. Neither Sarantos nor Shie ever suggests using a cylindrical lens in a PPG sensor in the manner that Apple proposed. Shie has nothing to do with physiological monitoring or PPGs. There is no evidence that a POSITA would have recognized a cylindrical lens in Shie as potentially solving any problem with Sarantos or as providing any potential benefits. Apple and Dr. Anthony presented no evidence confirming any of its allegations. Instead, their alleged motivations are pure speculation.

114. As I also explained above, Sarantos' HAR photodetectors were specifically tailored for Sarantos' light source. Apple's proposed combination would negate Sarantos' design. *See supra* Section VIII.B. In my opinion, a POSITA would not have had any motivation to combine Sarantos with a cylindrical lens from Shie.

[redacted]

2. Claim 12

115. Apple argued that a POSITA would have combined Sarantos and Shie with a Light Shaping Diffuser (LSD) from Savant in order to change the shape of light into a circular geometry. However, Apple did not present any evidence showing that the "second shape" of light would be different than the "first shape" of light in this proposed combination. In fact, I believe that Apple's arguments for Claim 12 are inconsistent with the position that it argued, and the ITC accepted, in the ITC Investigation.

116. As noted above, the correct analysis for the "second shape" limitation would have to compare the shapes of light before and after the supposed Savant LSD in Apple's proposed combination. Apple did not present that analysis. Instead, Apple and Dr. Anthony relied on a passage in Savant describing how an LSD "can be made to collect incoming light and either (1) distribute it over a circular area from a fraction of a degree to over 100°, or (2) send it into an almost unlimited range of elliptical angles." EX1012 at 1:37-40; 1465 Pet. at 70-71, EX1003-1465 ¶¶ 207-208. However, that passage does not describe how the shape of light would appear after the LSD. Rather, it is describing how light passing through an LSD could be projected onto a target downstream of the LSD. *See* EX1012 at 1:34-37 ("LSDs can be used to shape a light beam so that over 90% … of the light beam entering the LSD is directed towards and into contact with ***a target located downstream of the***

LSD."); *see also id.* at 1:41-44 (discussing how an LSD would produce a "rear projection screen"). How the light would appear when projected downstream of the LSD does not speak to what the shape of light would be after the LSD. Thus, Apple failed to present sufficient evidence that the "second shape" is different than the "first shape" as required by the base independent Claim 1.

117. Even supposing that the "second shape" of light were circular, as Apple and Dr. Anthony argued, that would still not meet the claim limitations. Apple presented no analysis of what the shape of light would be before the LSD, so as to confirm whether the "second shape" is different than the "first shape." And as I originally noted in EX2002-1465 ¶ 117, the light source in Sarantos is already depicted as circular. *See* EX1005, Figs. 15-16 (light sources 1508, 1608). If the shape of light before and after the supposed Savant LSD are both circular, then they do not meet the claim limitations.

118. I also reiterate that Apple and Dr. Anthony failed to demonstrate that a POSITA would have been motivated to combine Sarantos with Shie and Savant. *See* EX2002, ¶¶ 118-119. Apple and Dr. Anthony presented various arguments that are very similar to the arguments they presented for Claim 25. 1465 Pet. at 71-72; EX1003-1465 ¶ 209. But again, not a single one of those arguments is supported by any prior art or other contemporaneous evidence. And again, neither Shie nor Savant have anything to do with physiological monitoring, let alone PPG sensors. Savant

is a reference that discloses how to *manufacture* an LSD. There is nothing that would have suggested to a POSITA that they should combine an LSD from Savant into Sarantos. As I mentioned previously, Savant has nothing to do with physiological monitoring devices. Rather, it describes a manufacturing process for making a "Light Shaping Diffuser™." *See* EX2002-1465, ¶¶ 69, 119. Again, Apple's and Dr. Anthony's supposed motivations are all hindsight-driven speculation.

119. Moreover, as I noted above, Sarantos' HAR photodetectors were specifically tailored for Sarantos' light source. Apple's proposed combination would negate Sarantos' design. *See supra* Section VIII.B. In my opinion, a POSITA would not have had any motivation to combine Sarantos with an LSD from Savant.

XI. CONCLUSION

120. For at least the foregoing reasons, including the reasons previously expressed in my original declarations, it is my opinion that the challenged '745 Patent claims would not have been obvious.