Filed on behalf of Patent Owner
By: Todd R. Walters, Esq. (todd.walters@bipc.com)
Roger H. Lee, Esq. (roger.lee@bipc.com)
Mythili Markowski, Ph.D., Esq. (mythili.markowski@bipc.com)
Andrew R. Cheslock, Esq. (andrew.cheslock@bipc.com)
BUCHANAN INGERSOLL & ROONEY PC
1737 King Street, Suite 500
Alexandria, Virginia 22314
Main Telephone (703) 836-6620
Main Facsimile (703) 836-2021

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

DENTAL IMAGING TECHNOLOGIES CORPORATION
Petitioner

v.

3SHAPE A/S
Patent Owner

Case No. IPR2023-00400
Patent 10,695,151

PATENT OWNER'S PRELIMINARY RESPONSE

TABLE OF CONTENTS

Page

I. INTRODUCTION 1

II. STATEMENT OF THE PRECISE RELIEF REQUESTED 3

III. THE ’151 PATENT 4

IV. CLAIM CONSTRUCTION 6

V. ARGUMENT 9

A. Petitioner Fails to Demonstrate a Reasonable Likelihood That the Petitioner Would Prevail with Respect to at Least One of the Claims Challenged in Ground 1 12

1. Petitioner Fails to Demonstrate That Babayoff, Chu or any Combination Thereof Discloses Each of the Limitations of the Independent Claims 12

2. Petitioner Fails to Demonstrate That a POSA Would Have had Motivation to Combine Chu with Babayoff to Arrive at the Claimed Invention 21

a. Neither Babayoff nor Chu Describe Determining a Shade Value as Recited in the Claims 22

b. Babayoff Discloses an Automated Shade Mapping Technique not a Manual Method for Determining a Tooth Shade Value 22

c. A POSA Would Not Have Substituted the 3D Shade Mapping Technique of Babayoff with the 2D Shade Matching Technique of Chu 25

3. Petitioner Fails to Demonstrate That a POSA Would Have Had a Reasonable Expectation of Success in Combining Babayoff and Chu to arrive at the Claimed Invention 27

B. Petitioner Fails to Demonstrate a Reasonable Likelihood of Success That the Petitioner Would Prevail with Respect to at Least One of the Claims Challenged in Grounds 2 and 3 37

C. Petitioner Fails to Demonstrate a Reasonable Likelihood That the Petitioner Would Prevail with Respect to at Least One of the Claims Challenged in Ground 4 37

1. Petitioner Fails to Demonstrate That Babayoff, Inglese or any Combination Thereof Discloses All of the Limitations of the Independent Claims 38

2. Petitioner Fails to Demonstrate That a POSA Would Have Been Motivated to Combine Babayoff with Inglese to Arrive at the Claimed Invention 42

3. Petitioner Fails to Demonstrate That a POSA Would Have Had a Reasonable Expectation of Success in Combining Babayoff with Inglese to Arrive at the Claimed Invention 45

D. Petitioner Fails to Demonstrate a Reasonable Likelihood That the Petitioner Would Prevail with Respect to at Least One of the Claims Challenged in Grounds 5-6 49

VI. CONCLUSION 50

APPENDIX A – LIST OF EXHIBITS

TABLE OF AUTHORITIES

Cases **Page(s)**

Data Engine Techs. LLC v. Google LLC,
10 F.4th 1375 (Fed. Cir. 2021) 6

Graham v. John Deere Co. of Kansas City,
383 U.S. 1 (1966).....10

Intelligent Bio-Systems, Inc. v. Illumina Cambridge Ltd.,
821 F.3d 1359 (Fed. Cir. 2016) 11

In re Kahn,
441 F.3d 977 (Fed. Cir. 2006) 11, 34

KSR Int'l Co. v. Teleflex Inc.,
550 U.S. 398 (2007).....10, 11, 34

In re Merck & Co., Inc.,
800 F.2d 1091 (Fed. Cir. 1986) 11

Mobile Telecomms. Techs., LLC v. United Parcel Service, Inc.,
No. 12-cv-3222, 2014 WL 1274003 (N.D. Ga. Mar. 17, 2014).....8

O2 Micro Int'l Ltd. v. Beyond Innovation Tech. Co.,
521 F.3d 1351 (Fed. Cir. 2008) 8

Xerox Corp. v. Bytemark, Inc.,
IPR2022-00624, Paper 9 (PTAB Aug. 24, 2022).....*passim*

Statutes

35 U.S.C. § 103.....10

35 U.S.C. § 103(a) 10

35 U.S.C. § 311.....9

35 U.S.C. § 313.....9

35 U.S.C. § 314(a) 9

Rules

37 C.F.R. § 42.100(b) 6

37 C.F.R. § 42.108(c).....9

37 C.F.R. § 42.207(b) 1

I. INTRODUCTION

Patent Owner, 3Shape A/S ("3Shape" or "Patent Owner"), submits this Patent Owner's Preliminary Response to the Petition for *Inter Partes* Review ("Petition" or "Pet.") filed by DENTAL IMAGING TECHNOLOGIES CORPORATION ("DITC" or "Petitioner") against U.S. Patent No. 10,695,151 (EX1001, "the '151 Patent"). This paper is timely filed pursuant to 37 C.F.R. § 42.207(b) and the Notice of Filing Date Accorded to Petition and Time for Filing Patent Owner Preliminary Response (Paper 4).

Petitioner fails to show with a reasonable likelihood that it would prevail on at least one claim with respect to Grounds 1-3 for at least the following three reasons. First, none of Babayoff (U.S. Patent No. 7,698,068, issued on April 13, 2010; EX1105), Chu (Chu et al., "Dental Color Matching Instruments and Systems. Review of Clinical and Research Aspects," Journal of Dentistry, 38 Supp 2:e2-16, 2010; EX1106), or Graham (U.S. Patent Publication No. 2005/0074718, published on April 7, 2005; EX1107) either alone or in combination disclose all of the features of the challenged claims. For example, each of independent Claims 1, 13, and 14 require determining a tooth shade value for at least one point on the tooth based on the texture data of the corresponding point of the digital 3D representation and on known texture values of one or more reference tooth shade values. Petitioner repeatedly states that this feature is not disclosed by Babayoff. Likewise, this feature

is not disclosed by Chu or Graham. Thus, no combination of the references discloses all features of the claimed invention. Second, a POSA would not have had the motivation to combine Babayoff with Chu or Graham to arrive at the claimed invention. Petitioner's purported motivation to combine the references hinges on the faulty premise that Babayoff discloses a manual shade matching function as part of its method of determining a shade value. This premise is not correct and a POSA would not have been motivated to combine Chu with Babayoff to arrive at the claimed invention. Third, a POSA would not have had a reasonable expectation of success when combining Babayoff with Chu and Graham to arrive at the claimed invention. Petitioner makes no effort to explain how Chu's standard two-dimensional ("2D") image data from digital cameras and spectrophotometers is aligned with Babayoff's non-analogous three-dimensional ("3D") model derived from a confocal microscopy system.

Petitioner also fails to show with a reasonable likelihood that it would prevail on at least one claim with respect to Grounds 4-6 for at least the following three reasons. First, none of Babayoff, Inglese (U.S. Patent Publication No. 2010/0201986, published on August 12, 2010; EX1109), or Nathaniel (U.S. Patent Publication No. 2011/0188726, published on August 4, 2011; EX1111) either alone or in combination disclose all of the features of the challenged claims. As mentioned above, and as admitted by Petitioner, Babayoff does not disclose determining a tooth

shade value for at least one point on the tooth based on the texture data of the corresponding point of the digital 3D representation and on known texture values of one or more reference tooth shade values. Likewise, this feature is not disclosed by Inglese or Nathaniel. Thus, no combination of the references discloses all features of the claimed invention. Second, a POSA would not have had the motivation to combine Babayoff with Inglese or Nathaniel to arrive at the claimed invention. Again, Petitioner's purported motivation to combine the references hinges on the faulty premise that Babayoff discloses a manual shade matching function as part of its method of determining a shade value. This premise is not correct and a POSA would not have been motivated to combine Inglese with Babayoff to arrive at the claimed invention. Third, a POSA would not have had a reasonable expectation of success when combining Babayoff with Inglese and Nathaniel to arrive at the claimed invention. Petitioner makes no effort to explain how Inglese's standard two-dimensional ("2D") image data is aligned with Babayoff's three-dimensional ("3D") model derived from a confocal microscopy system.

II. STATEMENT OF THE PRECISE RELIEF REQUESTED

Patent Owner requests that the Board deny institution of the Petition with respect to all challenged claims and all asserted grounds. A full statement of the reasons for the relief requested is set forth in Sections III-IV below.

III. THE '151 PATENT

The '151 Patent discloses a method, a user interface and a system for use in determining shade of a patient's tooth, wherein a digital 3D representation including shape data and texture data for the tooth is obtained. EX1001, Abstract. Independent Claims 1, 13 and 14 of the '151 Patent are challenged in this IPR. All other challenged claims directly or indirectly depend from Claims 1, 13 and 14. Each of the independent claims is reproduced below.

> 1. A method for determining shade of a patient's tooth, wherein the method comprises:
>
> obtaining a digital 3D representation of the tooth, where the digital 3D representation comprises shape data and texture data for the tooth; and
>
> determining a tooth shade value for at least one point on the tooth based on the texture data of the corresponding point of the digital 3D representation and on known texture values of one or more reference tooth shade values,
>
> wherein the method comprises deriving a certainty score expressing the certainty of the determined tooth shade value.
>
> 13. A method for determining shade of a patient's tooth, wherein the method comprises:
>
> obtaining a digital 3D representation of the tooth, where the digital 3D representation comprises shape data and texture data for the tooth; and

determining a tooth shade value for at least one point on the tooth based on the texture data of the corresponding point of the digital 3D representation and on known texture values of one or more reference tooth shade values,

wherein the method comprises creating a shade profile for the tooth from shade values determined one or more points on the tooth,

wherein the tooth shade profile comprises a one or more tooth shade regions on the tooth surface where an average tooth shade is derived for each region from tooth shade values determined for a number of points within the region.

14. A method for determining shade of a patient's tooth, wherein the method comprises:

obtaining a digital 3D representation of the tooth, where the digital 3D representation comprises shape data and texture data for the tooth; and

determining a tooth shade value for at least one point on the tooth based on the texture data of the corresponding point of the digital 3D representation and on known texture values of one or more reference tooth shade values,

wherein obtaining the digital 3D representation of the tooth comprises recording a series of sub-scans of the tooth, where at least one of said sub-scans comprises both texture information and geometry information for said tooth, and generating the digital 3D representation of the tooth from the recorded series of sub-scans.

Petitioner fails to demonstrate unpatentability of the challenged claims for at least the reasons set forth below.

IV. CLAIM CONSTRUCTION

The standard for claim construction in *inter partes* review is the "ordinary and customary meaning of such claim as understood by one of ordinary skill in the art and the prosecution history pertaining to the patent." 37 C.F.R. § 42.100(b). Petitioner states "for purposes of this proceeding, all claim terms should be given their ordinary and customary meaning." Pet. at 16. Petitioner is not taking consistent positions between this proceeding and the parallel district court proceeding. Quite the contrary, Petitioner has alleged constructions and indefiniteness in the parallel proceeding. *See* EX2001. It is improper to construe the terms one way for invalidity and another for infringement. *Data Engine Techs. LLC v. Google LLC*, 10 F.4th 1375, 1381 (Fed. Cir. 2021). Patent Owner here maintains the claim construction positions it has taken in the parallel district court proceeding. *Compare* below with EX2002.

The terms "shape," "texture," and "data" are commonly used terms, used consistent with their normal definitions in the specification and claims. There is no "express definition" in the specification. Rather, the specification provides explanatory language about shape and texture data in relation to the digital 3D representation. EX1001, 2:32-54. The specification provides that "texture data"

includes at least color data, which is used to compare the tooth shade value at a point on the 3D model against a reference tooth shade value. '151 Patent at 5:51-54 ("When the texture data comprises color data, selecting the tooth shade value of the point can comprise calculating the color difference between the determined color data in the point and the color data of the reference tooth shade values.") (emphasis added); *see also id.* at 2:39-45 ("the texture data expressing a texture profile of the tooth may be color data expressing a color profile of the tooth….") (emphasis added). The specification explains that the "texture data" is derived from "texture information" and that texture information comprises color or surface roughness data. *Id.* at 2:37-38 ("In some embodiments, the texture information comprises at least one of tooth color or surface roughness."); *see also* 3:9-12, 4:33-40, 4:51-61, 5:14-19. Since "texture data" is derived from texture information, it also must include "at least one of color and surface roughness."

Petitioner claims in the parallel district court proceeding that a construction is necessary to "eliminate any ambiguity by specifying that the data relates to the [shape or texture] 'of the tooth.'" EX2001, at 24. But the claims already state, "where the digital 3D representation comprises shape data and texture data *for the tooth*." *See* Claims 1, 13, 14. Claim construction "is not an obligatory exercise in redundancy;" rather, it "is a matter of resolution of disputed meanings and technical scope, to clarify and *when necessary* to explain what the patentee covered by the

claims." *O2 Micro Int'l Ltd. v. Beyond Innovation Tech. Co.*, 521 F.3d 1351, 1362 (Fed. Cir. 2008) (emphasis added).

Petitioner wrongly concludes in the parallel district court proceeding that because the specification defines "certainty score," no construction is necessary. EX2001, at 24-26. That is not the standard. Unlike the commonly used terms like shape, texture, and data, discussed above, "deriving a certainty score" is not a term generally used by those skilled in the art. And, Petitioner fails to state the "plain and ordinary meaning" of the phrase. *See generally* EX2001, at 10-12; *see also Mobile Telecomms. Techs., LLC v. United Parcel Service, Inc.*, No. 12-cv-3222, 2014 WL 1274003 at *6 (N.D. Ga. Mar. 17, 2014) (simply arguing the ordinary meaning applies "does not necessarily mean that the Court should not supply to the jury such an ordinary meaning") (internal citation omitted).

3Shape's proposed construction provides information on what the "certainty score" is– an "accuracy value"–and specifies from what information it is "derived": "determin[ed] … based on the tooth shade value, the texture data, and/or the texture information." 3Shape's construction should be adopted because it clarifies the scope and meaning of the term and will therefore be of more assistance to the jury. In claiming that 3Shape's proposed construction "merely replaces the claim language with a similar phrase that does not improve comprehension" (EX2001, at 25-26), Petitioner entirely ignores the part of 3Shape's construction that describes the

sources from which the value is derived, *i.e.*, the tooth shade value, the texture data, and/or texture information.

The decision on whether to institute trial is not dependent on the constructions that the parties offered in the parallel litigation. Nevertheless, Petitioner fails to demonstrate a reasonable likelihood of success under any construction whether it be its asserted constructions here or its asserted constructions in the district court.

V. ARGUMENT

Institution should be denied because Petitioner has failed to establish a reasonable likelihood that the Petitioner would prevail with respect to any ground or any challenged claim. There are at least three reasons to deny institution. First, there is at least one limitation missing in the combination of references. Second, Petitioner has not established a motivation with reasonable underpinnings to combine the asserted art to arrive at the claimed invention. Third, Petitioner has failed to provide evidence that a POSA would have had a reasonable expectation of success in combining the art to arrive at the claimed invention.

The Director may not authorize an inter partes review to be instituted unless the Director determines that the information presented in the petition filed under section 311 and any response filed under section 313 show that there is a reasonable likelihood that the Petitioner would prevail with respect to at least one of the claims challenged in the petition. 35 U.S.C. § 314(a); 37 C.F.R. § 42.108(c).

The Petition sets forth six grounds of alleged unpatentability. Pet. at 1-2. In "Ground 1," Petitioner alleges that Claims 1, 2, 6, 7, and 9-15 are unpatentable under AIA 35 U.S.C. § 103 as obvious based on Babayoff in view of Chu. In "Ground 2," Petitioner alleges that Claim 3 is unpatentable under AIA 35 U.S.C. § 103 as obvious based on Babayoff in view of Chu and Graham. In "Ground 3," Petitioner alleges that Claims 15-17 are unpatentable under AIA 35 U.S.C. § 103 as obvious based on Babayoff in view of Chu and Nathaniel. In "Ground 4," Petitioner alleges that Claims 1, 2, 7, and 9-15 are unpatentable under AIA 35 U.S.C. § 103 as obvious based on Babayoff in view of Inglese. In "Ground 5," Petitioner alleges that Claim 3 is unpatentable under AIA 35 U.S.C. § 103 as obvious based on Babayoff in view of Inglese and Graham. In "Ground 6," Petitioner alleges that Claims 15-17 are unpatentable under AIA 35 U.S.C. § 103 as obvious based on Babayoff in view of Inglese and Nathaniel.

To establish obviousness of a claimed invention under 35 U.S.C. § 103(a), Petitioner must establish that "the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person of ordinary skill in the art to which said subject matter pertains." *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 406 (2007) (citing *Graham v. John Deere Co. of Kansas City*, 383 U.S. 1 (1966)). A patent claim composed of several elements is not proved obvious merely

by demonstrating that each of its elements was known, independently, in the prior art. *See KSR*, 550 U.S. at 418.

Further, the appropriate inquiry into obviousness requires that "one must have a motivation to combine accompanied by a reasonable expectation of achieving what is claimed in the patent-at-issue." *Intelligent Bio-Systems, Inc. v. Illumina Cambridge Ltd.*, 821 F.3d 1359, 1367 (Fed. Cir. 2016). Thus, the requirement for a motivation to combine references is separate from the requirement for a person of ordinary skill in the art to have a reasonable expectation of success in combining the cited references to meet the limitations of the claimed invention. *Id*. *See also In re Merck & Co., Inc.*, 800 F.2d 1091 (Fed. Cir. 1986).

"[R]ejections on obviousness grounds cannot be sustained by mere conclusory statements; instead, there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness." *In re Kahn*, 441 F.3d 977, 988 (Fed. Cir. 2006); *see also KSR*, 550 U.S. at 418. The Petition does not provide articulated reasoning based on rational underpinnings for why one of ordinary skill in the art would have modified the asserted art to arrive at the claimed invention.

Petitioner fails to demonstrate a reasonable likelihood of success with respect to all challenged claims and all grounds presented in the Petition. The deficiencies of the Petition are discussed below.

A. Petitioner Fails to Demonstrate a Reasonable Likelihood That the Petitioner Would Prevail with Respect to at Least One of the Claims Challenged in Ground 1

Petitioner fails to establish a reasonable likelihood that the Petitioner would prevail with respect to at least one of the claims challenged in Ground 1 based on Babayoff and Chu for at least the following reasons. First, Petitioner fails to demonstrate that Babayoff, Chu or any combination thereof discloses each of the limitations of the independent claims. Second, Petitioner fails to demonstrate that there would have been motivation for a POSA to combine Babayoff with Chu to arrive at the claimed invention. Third, Petitioner fails to demonstrate that a POSA would have a reasonable expectation of success in combining Babayoff and Chu to arrive at the claimed invention.

1. Petitioner Fails to Demonstrate That Babayoff, Chu or any Combination Thereof Discloses Each of the Limitations of the Independent Claims

Independent Claims 1, 13 and 14 recite "determining a tooth shade value for at least one point on the tooth based on the texture data of the corresponding point of the digital 3D representation and on known texture values of one or more reference tooth shade values." Petitioner asserts that Babayoff in combination with Chu satisfies this recitation of the independent claims. Pet. at 20. However, Petitioner is not only incorrect but also fails to explain how either Babayoff or Chu disclose this feature of the claims.

Petitioner admits that "it is not apparent that Babayoff discloses determining a tooth shade value for at least one point on the tooth based on the color data c of the corresponding point of the digital 3D representation and on known color values of one or more reference tooth shade values." *Id.* 21. Thus, there is no dispute that Babayoff fails to disclose this feature of the claimed invention.

Petitioner relies on Chu to make up for the deficiencies of Babayoff. However, like Babayoff, Chu fails to disclose the step for determining a tooth shade value as recited in independent Claims 1, 13, and 14.

According to Petitioner, because Chu discloses selection of a tooth shade value, *e.g.*, A1 or B1 or B2, based on a comparison of measured color data with reference color values (expressed in terms of the difference between measured and reference color characteristics L*a*b* or L*C*h°), Chu discloses "determining a tooth shade value for at least one point on the tooth based on the texture data of the corresponding point of the digital 3D representation and on known texture values of one or more reference tooth shade values." (citing its expert in EX1003, ¶89). *Id*. at 25. However, Petitioner's analysis is not only wrong, it is completely conclusory.

At the outset, Petitioner only cites to the declaration of its expert in support of the assertion that Chu discloses the missing feature of Babayoff. Petitioner's expert merely mimics the Petition. *See* EX1003, ¶89. There are no underlying facts in support of the assertion that Chu discloses "determining a tooth shade value for at

least one point on the tooth based on the texture data of the corresponding point of the digital 3D representation and on known texture values of one or more reference tooth shade values." In such cases, the Director has been clear that institution should be denied when the expert declaration presents conclusory assertions without underlying factual support and repeats verbatim the petitioner's argument. *Xerox Corp. v. Bytemark, Inc.*, IPR2022-00624, Paper 9 (PTAB Aug. 24, 2022), Paper 12 (PTAB Feb 10, 2023).

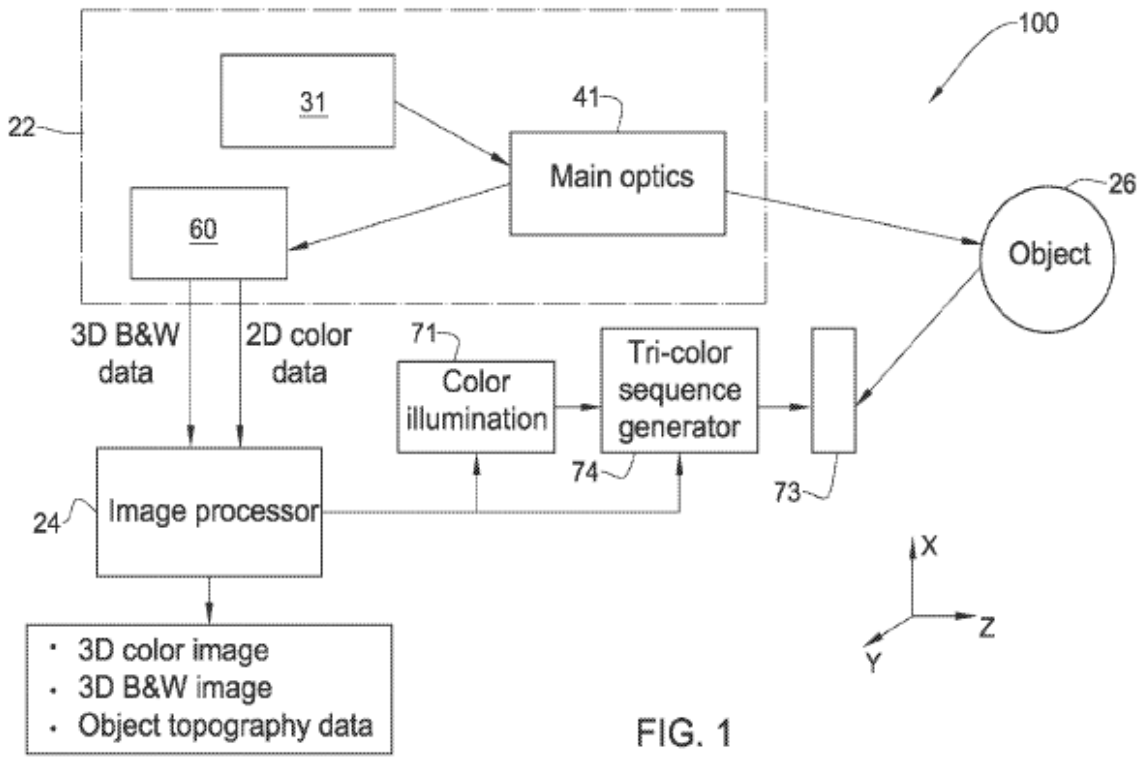
Babayoff discloses a device and method for providing data useful in obtaining 3D surface geometry and color of at least one part of the oral cavity such as a tooth. EX1105, Abstract. The device makes use of confocal imaging for providing an accurate three-dimensional representation of the target surface within the intra-oral cavity. *Id.* 8:15-17. Color values are then derived for each data point of this data set thereby obtaining a two-dimensional color image of the target surface, and then mapping the color values of the two-dimensional image onto the three-dimensional image. *Id.* 8:18-22.

The Babayoff device creates a numerical entity set of a plurality of 4D arrays (x,y,z,c) wherein each array represents the x,y,z, geometrical coordinates and the color c of a point on a surface within the intra-oral cavity. EX1105, 8:9-12. The device includes detection optics that receives image data from the main optics and an image processor determines the Z depth values for each X-Y point

illuminated on the object. *Id.,* 8:30-44. The device is further configured to provide color data for an array of X-Y points that is according to the same frame of reference as the X-Y array used for obtaining the 3D entity. *Id.,* 8:53-56. The color is provided using a CCD camera having a matrix of sensing elements each representing a pixel of the image and each one corresponding to one pinhole in a matrix in the imaging optic. *Id.,* 11:20-34.

As shown below, the Babayoff device 100 comprises a main illumination source 31 for illuminating the object of interest 26, typically a part of the intraoral cavity, and is optically coupled to main optics 41 to provide depth Z values for an array range of X-Y points (according to a known frame of reference) along the surface of the object 26. EX1105 8:30-38. Detection optics 60 comprises an image sensor, typically a CCD, that is preferably monochromatic to maximize the resolution of the device, and which typically defines the X-Y frame of reference. *Id.* The device 100 further comprises color illuminating means, such as for example a tri-color sequence generator 74, for selectively illuminating the object 26 with suitable colors, typically Green, Red and Blue, and for each such monochromatic illumination, a 2D image of the object 26 is captured by the detection optics 60. *Id.* 8:45-56. The processor 24 then processes the three differently colored monochromatic images and combines the same to provide a full color 2D image of the object. *Id.* The device 100 is configured for providing color data for an array of

X-Y points that is according to the same frame of reference as the X-Y array used for obtaining the 3D entity. *Id.*



EX2003, Fig. 1.

Chu discloses the use of various spectrophotometers (EX1106, e4) to match shade areas to assist in identifying the color of a tooth. *Id.* There are no diagrams illustrating any of the components of any of the devices described in Chu. However, Chu explains that spectrophotometers include a source of optical radiation, a means of dispersing light, an optical system for measuring, a detector and a means for converting light obtained to a signal that can be analyzed. *Id.*

These devices measure the amount of light energy reflected from an object at 1-25nm intervals along the visible spectrum. *Id.*

A spectrophotometer measures spectral reflectance of an object at different wavelengths. EX2007, p. 88. Spectrophotometers have an aperture typically between 3 and 5 mm. EX2008, p. 33. They allow the user to measure reflectance from diameter areas of 3-5 mm of the tooth being measured. EX1106, e4. Therefore, several areas of the tooth should be considered to obtain a representative evaluation of tooth shade. *Id.* Chu explains that small-window tooth color measurement may cause edge loss of the light due to a tooth's translucency. *Id.* Chu explains that spectrophotometers are predominantly intended for shade analysis, however, this information alone may be insufficient for the technician to adequately interpret the shade information provided. *Id.* at e5. Subsequent reference photography is highly recommended for communication on tooth color. *Id.*

The Babayoff device is completely different and non-analogous to the Chu spectrophotometer devices. Babayoff discloses obtaining a 3D model having color. The spectrophotometers in Chu provide 2D color data alone. The Babayoff device obtains color data for points on the tooth. The spectrophotometers in Chu obtain color data for areas on the tooth. The Babayoff device places the color data in the same frame of reference as the X-Y array used for the 3D model. The

spectrophotometers in Chu provide color for 2D image areas and there is no frame of reference for points in an X-Y array. Simply put, the spectrophotometers described in Chu do not provide any data that would be useful for the Babayoff device.

Petitioner relies on Figure 1 of Chu which purportedly illustrates clinical application of a CrystalEye spectrophotometer. *Id.* at 21-22. According to Petitioner, the "Reference" tooth shade guide and tooth shade value are depicted in Figure 1(d) as follows:

Id., FIG. 1(d) (annotated by Petitioner).

There is nothing in the Fig. 1(d) that indicates that Chu determines a tooth shade value for at least one point on the tooth based on the texture data of the corresponding point of the digital ***3D representation***. There is ***no 3D representation*** of a tooth in Fig. 1(d) of Chu. *See* above. In fact, Chu explicitly states that CrystalEye combines the benefits of a traditional spectrophotometer with digital photography. EX1106 at e4. CrystalEye spectrophotometer "mappings are two dimensional and they do not necessarily take into account the shape, texture, or thickness of the restoration." *Id.* Such spectrophotometer devices do not provide a ***3D representation*** having texture data. And, for the reasons described above, one cannot use a spectrophotometer to determine a tooth shade value for at least one point on a tooth. Spectrophotometers provide data for 2D areas, not points on a digital 3D representation. Indeed, a spectrophotometer does not even provide data for specific X-Y points commensurate with what is described in Babayoff.

Petitioner further relies on statements in Fig. 1(d) of Chu that indicate that "[c]olor difference ΔEs obtained in all 3 areas are considered to be excellent color match." EX1106 at e6. Petitioner's expert states that the closeness of the match is depicted, in part, by L*a*b* color comparisons between the measured color data and the known color values of the reference tooth shade value. EX1003, ¶85. However, Petitioner and its expert fail to explain how Chu's purported disclosure of closeness

of the match of color values relates to determining a tooth shade value for at least one point on the tooth based on the texture data of the corresponding point of the digital ***3D representation***. Chu makes no mention of basing its color comparison on **a corresponding point** of a digital ***3D representation***. Again, the CrystalEye system provides color for areas on 2D images not color for points in a 3D representation of a tooth.

Petitioner further cites to Fig. 5 of Chu which illustrates clinical application of a SpectroShade Micro spectrophotometer. *Id.* at 23-25. Fig. 5 of Chu does not make up for the deficiencies of Babayoff.

Like the CrystalEye spectrophotometer, the SpectroShade Micro spectrophotometer uses a digital camera/LED spectrophotometer combination. It produces 2D images and spectral data that can be saved and transferred to a computer. EX1106 at e4. Like with the CrystalEye spectrophotometer mappings, Chu explicitly states that the SpectroShade spectrophotometers are 2D and they do not "necessarily take into account shape, texture, [or] thickness. " EX1106 at e4. Such spectrophotometer devices do not provide texture data **for points** on a ***3D representation***. Certainly, nothing in Fig. 5 indicates that Chu determines a tooth shade value for at least one point on the tooth **based on the texture data of the corresponding point** of a digital ***3D representation***. Chu does not obtain color data for points and there is no 3D representation of a tooth in Fig. 5 of Chu.

Petitioner admits that Babayoff fails to disclose the recited step of determining a tooth shade value for at least one point on the tooth as recited in Claims 1, 13, and 14. Further, Chu fails to make up for the deficiency of Babayoff because Chu does not disclose determining a tooth shade value for at least one point on the tooth based on the texture data of the corresponding point of a digital 3D representation. For this reason alone, Petitioner fails to establish with a reasonable likelihood that any of the independent Claims 1, 13 or 14 are unpatentable.

2. Petitioner Fails to Demonstrate That a POSA Would Have had Motivation to Combine Chu with Babayoff to Arrive at the Claimed Invention

Ground 1 is based on Petitioner's assertion that a POSA would have been motivated to combine Chu with Babayoff to determine a shade value as recited in independent Claims 1, 13, and 14. Petitioner's assertions are wrong for at least three reasons. First, as disclosed above, Chu does not disclose determining a shade value based on texture data of the corresponding point of a digital 3D model and on known texture values of one or more reference tooth shade values. Second, Petitioner's allegations of motivation are based on the false premise that Babayoff requires ***manual*** shade matching when in fact Babayoff discloses an ***automated*** method of mapping the shade of a prosthesis based on surrounding teeth. Third, one would not substitute Babayoff's 3D shade mapping technique with Chu's shade matching technique.

a. Neither Babayoff nor Chu Describe Determining a Shade Value as Recited in the Claims

As discussed above in § V.A.1., Petitioner explicitly admits that Babayoff does not disclose "determining a tooth shade value for at least one point on the tooth based on the color data c of the corresponding point of the digital 3D representation and on known color values of one or more reference tooth shade values." Pet. at 21. Likewise, as discussed above in § V.A.1., Chu fails to disclose this recitation. Thus, even if the references are combined there is no motivation to determine a tooth shade value as recited in Claims 1, 13, and 14.

b. Babayoff Discloses an Automated Shade Mapping Technique not a Manual Method for Determining a Tooth Shade Value

Petitioner asserts that "rather than compare the measured texture values to the measured texture values of reference teeth and manually selecting a tooth shade value, as taught by Babayoff, Chu teaches automatically comparing the color data to known color values of reference tooth shade values from a shade guide." Pet. at 28. Petitioner's expert states that "[a]lthough Babayoff discloses algorithmically determining tooth color based on surrounding teeth it still requires visual comparison with a reference shade guide to determine a tooth shade value." EX1003, ¶91. Thus, according to Petitioner, a POSA would have been motivated to substitute Babayoff's purported "shade matching function" with Chu's automated "shade matching function." Pet. at 28. However, once again, Petitioner and its expert fail to provide

any citation to Babayoff in support of the assertion that Babayoff requires a visual or manual comparison with a reference shade guide to determine a tooth shade value. The assertion that Babayoff requires visual comparison with a reference shade guide to determine a tooth shade value is completely conclusory and should be given little weight. *Xerox Corp. v. Bytemark, Inc.*, IPR2022-00624, Paper 9 (PTAB Aug. 24, 2022), Paper 12 (PTAB Feb 10, 2023).

Babayoff makes clear that visual or manual comparisons are the traditional method of shade matching. Babayoff states in the Background of the Invention the following:

> **Traditional methods of color matching are based on visual comparison between a removable tooth-shaped color tab of a shade guide**, such as for example Vita, and the surrounding teeth. The practitioner can then choose the standard shade that best matches the overall color of the other teeth. The appropriate shade reference can then be communicated to the laboratory that is to manufacture the prosthesis.

EX1105, 2:29-36 (emphasis added).

Babayoff describes in its fourth embodiment the shading of a prosthesis. EX1105, at 26. As with other embodiments, the first step in the fourth embodiment is the creation of a numerical entity I of the region of interest. *Id.* The numerical entity I is a data set representing the surface geometry and color of at least a portion of the intraoral cavity that contains an area of interest. EX1105, 21:3-8. The shading

characteristics of the prosthesis are to be based on the shading characteristics of at least one tooth of the patient not on a shade guide. *Id.* The shading characteristics may be obtained based on color, variations in hue, other reflective qualities, and translucency, "**according to any desired set of rules or algorithm**." *Id.* In the next steps of the fourth embodiment, the entity I is manipulated to extract the data corresponding to individual teeth. Thereafter, the decision is taken regarding which teeth are to be considered for modelling the shading of the prosthesis. EX1105, 26:31-51. The decision may be made **automatically**, for example, including only adjacent teeth. *Id.* The spatial relationship between the entity corresponding to the area of the prosthesis and the entities corresponding to the other teeth can be determined in an **automated manner** by simple geometrical rules. *Id.*

Babayoff specifically discloses, in its fourth embodiment, determining shade by (a) providing separate numerical sub-entities each associated with a different one of at least one tooth within said intra-oral cavity; (b) providing a prosthesis entity comprising surface geometrical data, said prosthesis entity being associated with a desired prosthesis; and *(c) mapping color data from at least one sub entity in step (a) to said prosthesis entity according to predetermined criteria.* EX1105, 5:33-46. Notably, in step (c) of the method for *providing shading data*, the color data, which as explained above is a numerical entity, is manipulated (*e.g.,* mapped) according to predetermined criterion to provide the shading data. Because Babayoff explains that

manipulations of numerical entities, which includes color data, is ***automated***, so too is the result of providing the shading data. Importantly, nothing in the above-described method for providing shade data requires visual inspection or any other manual operation to be performed. *See* EX1105, 26:8-26:66.

Babayoff mentions that "the choice [of which teeth are to be considered for modelling the shading of the prosthesis] may be made manually" (e.g., visually using a display screen and cursor). However, this description also specifies that the choice may be made "automatically" using a "suitable algorithm." EX1105, at 26:39-56. More importantly, the reference to a manual operation relates to picking teeth as a model for shading the prosthesis. There is no mention of the use of a shade guide to determine the shade of the prosthesis because the shade of the prosthesis is determined based on the selected teeth.

Accordingly, Petitioner and its expert are simply wrong when they assert that Babayoff requires a manual or visual inspection of color or shading characteristics. Instead, Babayoff describes an automated method of determining shade when making a prosthesis having the desired shading characteristics.

c. A POSA Would Not Have Substituted the 3D Shade Mapping Technique of Babayoff with the 2D Shade Matching Technique of Chu

Petitioner asserts that Chu would have provided a POSA with the motivation to modify Babayoff by explaining that automated shade matching increases the

success of color matching. Pet. at 26. According to Petitioner, Chu explains that automated shade matching reduces or overcomes imperfections and inconsistencies in traditional shade matching, which is subject to "innate difficulties." *Id.* Petitioner further asserts that a POSA would have sought to configure Babayoff's system by replacing Babayoff's purported manual shade matching function with Chu's automated shade matching function to allow for "increases [in] the success of color matching, communication, reproduction, and verification in clinical dentistry." *Id.* at 26-27. Petitioner's assertions of motivation are misplaced.

Chu explicitly states that the CrystalEye and SpectroShade devices "mappings are two dimensional and they do not necessarily take into account shape, texture, thickness of the restoration." EX1106, e4. Chu explicitly states that such devices "'average out' color data over the complete tooth surface or larger defined areas which can lead to inaccurate shade information." *Id.* Chu explicitly states that it obtains measurements for "3-5 mm diameter areas of the tooth being measured" not points of a digital 3D representation. *Id.* Babayoff, on the other hand, does not use shade matching which results in the inaccuracies of the 2D processes disclosed in Chu. Instead, Babayoff discloses using a confocal 3D system for mapping color to the prosthesis based on data obtained from surrounding teeth. EX1105, at 26. By using such method, Babayoff addresses the issue of local variations of color in the

teeth mentioned in the Background of the Invention of Babayoff (EX1001, 2:42-3:28).

The Babayoff device is completely different and non-analogous to the Chu device. Babayoff discloses obtaining a 3D model having color. The spectrophotometers in Chu provide 2D color data alone. The Babayoff device obtains color data for points on the tooth. The spectrophotometers in Chu obtain color data for areas on the tooth. The Babayoff device places the color data in the same frame of reference as the X-Y array used for the 3D model. The spectrophotometers in Chu provide color for 2D image areas and there is no frame of reference for points in an X-Y array. Simply put, the spectrophotometers described in Chu do not provide any data that would be useful for the Babayoff device nor does Petitioner explain how Chu's data would be implemented in Babayoff's method.

3. Petitioner Fails to Demonstrate That a POSA Would Have Had a Reasonable Expectation of Success in Combining Babayoff and Chu to arrive at the Claimed Invention

Petitioner asserts that "a POSA would have expected such a combination to work for its intended purpose because Chu describes prior art imaging systems capable of determining tooth shade values from measured color data and known color values of one or more reference tooth shaped values." Pet. at 27. However, this broad proposition is not supported by evidence. Petitioner and its expert merely

list the CrystalEye, SpectroShade, ShadeVision, and ClearMatch systems as devices that help to determine shade from a ***2D image***. *Id*. Petitioner admits that all of the devices disclosed by Chu are 2D imaging systems. And, Petitioner and its expert fail to explain how a POSA could have successfully combined the ***2D imaging systems* and shade guides** disclosed in Chu with the ***3D confocal imaging system*** in Babayoff to arrive at the claimed step of determining a shade value. *See* Pet. at 26-28, EX1003, ¶92.

At the outset, Petitioner asserts that a POSA would have understood how to implement the matching function of Chu. Pet. at 28. Petitioner merely states that (1) it was well known at the time of the alleged invention of the '151 Patent how to calculate tooth color by measuring light reflected on the surface of the tooth and expressing results in the CIE L*a*b*color space and matching those results to shade tabs of a guide system and (2) it was known how to express tooth shades in a shade guide system using conversion scales for CIEL *a*b* values based on internally stored data. *Id.* However, Petitioner failed to explain how a POSA would have implemented the shade matching function of Chu in Babayoff to map the shade of the prosthesis.

Petitioner thereafter asserts that a POSA would have been able to replace the shade matching function in Babayoff with the shade matching function as taught by Chu. Pet. at 28. However, as discussed above, Babayoff makes no mention of shade

matching as part of its method. Babayoff automatically determines tooth shade based on existing teeth and maps the shade of the prosthesis. Babayoff makes no mention of the need to match to a shade guide as part of its method.

Moreover, the Petition fails to account for the differences in methodologies in obtaining data and the resulting data sets. Babayoff's confocal scanning system captures a series of images by illuminating an object with an array of incident light beams arranged in an X-Y plane while moving the focus plane along the Z-axis relative to the object in order to obtain three-dimensional data of the object. EX1105, 10:65–11:39. "Incident light beams 48 form an array of light beams arranged in an X-Y plane, in the Cartesian frame 50, propagating along the Z axis. As the surface on which the incident light beams hits is an uneven surface, the illuminated spots 52 are displaced from one another along the Z axis, at different (X_i,Y_i) locations." *Id.* "Thus, while a spot at one location may be in focus of the optical element 42, spots at other locations may be out-of-focus." *Id.* "Therefore, the light intensity of the returned light beams (see below) of the focused spots will be at its peak, while the light intensity at other spots will be off peak." *Id.*

"The light scattered from each of the light spots includes a beam traveling initially in the Z-axis along the opposite direction of the optical path traveled by the incident light beams." EX1105, 10:65–11:39 "Each returned light beam **54** corresponds to one of the incident light beams 36." *Id.* "Given the

unsymmetrical properties of mirror 40, the returned light beams are reflected in the direction of the detection optics 60." *Id.* "The detection optics 60 comprises a polarizer 62 that has a plane of preferred polarization oriented normal to the plane polarization of polarizer 32." *Id.* Thus, the precise correspondence of the returned light beams (obtained at different positions of the focal plane) to a given X-Y pixel of the CCD is important because Babayoff's detection optics utilizes an array of pinholes 66 positioned upstream from the CCD 68 (highlighted below) to sustain its confocal imaging operation:

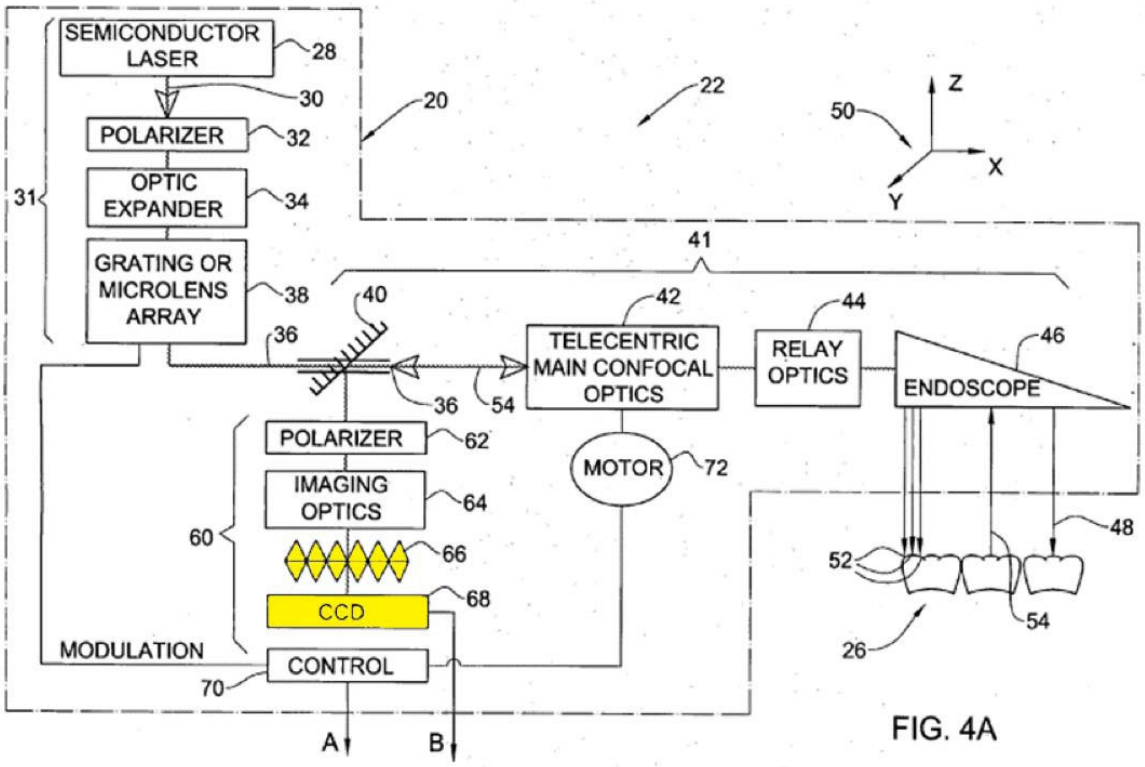


Fig. 4A of Babayoff (Annotated)

EX1105, Fig. 4A; 11:20-34.

As can be seen from Fig. 4A above and as described below, the returned light beams must pass through the pinhole array 66 before reaching the CCD 68 in Babayoff's detection optics:

> ***Each returned light beam 54 corresponds to one of the incident light beams 36….*** The returned polarized light beam 54 pass through an imaging optic 64, typically a lens or a plurality of lenses, and then through a matrix 66 comprising an array of pinholes. ***CCD camera has a matrix [of] sensing elements each representing a pixel of the image and each one corresponding to one pinhole in the array 66.***

EX1105, 11:20-34 (emphasis added). Thus, Babayoff teaches that each pixel of the CCD at a particular X-Y position precisely corresponds to one pinhole of the pinhole array 66 in corresponding X-Y position. EX1105, 10:64−11:55.

Babayoff further describes the use of a color illuminating means for selectively illuminating the object with suitable colors typically green, red and blue. For each monochromatic image, a two-dimensional image of the object is captured by the detection optics within the device. EX1105, 8:30- 9:32. The processor then processes the images and combines the same to provide a full color 2D image object. *Id.* ***The device is configured for providing a color array of X-Y points that is according to the same frame of reference as the X-Y array used for obtaining the 3D entity.*** *Id.* The processor aligns the 2D color image with the 3D entity previously

created, and then provides color values to this entity by mapping color values to the entity at aligned X-Y points. *Id.* Such alignment is straightforward because both the 3D data and the 2D color data are referenced to the ***same X-Y frame of reference***. *Id.*

In each of the embodiments described in Babayoff, the illumination radiation that is used for obtaining the 2D color image is injected into the optical axis of the confocal optics without affecting the operation thereof or degrading the 3D image capture. EX1105, 20:18-22. The scans are executed in relatively quick succession, and by the same or different image capturing means such as CCD's that are arranged such that the color 2D image substantially corresponds to the 3D entity. EX1105, 20:44-59. This enables color values at particular X-Y coordinates of the 3D image which also have a Z coordinate. *Id.*

Petitioner and its expert make no attempt to explain how one would use the devices described in Chu such as the CrystalEye, SpectroShade, ShadeVision, and ClearMatch products within the confocal apparatus described in Babayoff. Further, Chu does not describe how to implement such systems into a 3D confocal imaging system.

- There is no explanation how to implement Chu's 2D image into Babayoff's confocal imaging system.

- There is no explanation of which of the different systems from Chu would be combined with Babayoff.
- There is no explanation how a POSA would have implemented the devices described in Chu in Babayoff's system such that the 2D color image is injected into the optical axis of Babayoff's confocal optics without affecting the operation thereof or degrading the 3D image capture.
- There is no explanation how a POSA would have made scans using the devices described in Chu in quick succession through the optical axis in Babayoff's confocal optics without affecting the operation thereof or degrading the 3D image capture.
- There is no explanation how one might associate a Z-coordinate of Babayoff with the color data obtained by the Chu devices.
- There is no explanation of how a POSA would have Babayoff's processor align the 2D color image areas obtained by the Chu devices with the 3D entity previously created by Babayoff, and then provide color values to the entity at aligned X-Y points.
- There is no explanation of how one would associate an existing shade guide useful with a particular spectrophotometer with the data gathered by Babayoff's confocal imaging system.

Moreover, the Petition fails to account for differences in color space between Babayoff and Chu. Babayoff's utilizes a red, green and blue (RGB) color space. *See e.g.*, EX1105, 21:13-15. Chu relies on a L*a*b* color space. Pet. at 22. Yet Petitioner fails to provide any explanation of which color space is being used in the combination and whether or how Chu's L*a*b* color space would be adapted to use in Babayoff's RGB color space.

Petitioner and its expert merely side-step these issues by incorrectly stating that Babayoff discloses a manual shade matching process as part of its method (which it does not) and that Chu discloses a method for automatically shade matching. Pet. at 29; EX1003, ¶92. Then, Petitioner asserts the conclusory statement that "[a] POSA , therefore, would have been able to replace the shading matching function in Babayoff with the shade matching function as taught by Chu" without any explanation of how a POSA would have accomplished the combination. *Id.* Such assertions of obviousness cannot be sustained by mere conclusory statements; instead, there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness. *In re Kahn*, 441 F.3d 977, 988 (Fed. Cir. 2006); *see also KSR*, 550 U.S. at 418.

Petitioner has failed to address in the Petition the difficulties in using spectrophotometers to obtain color data of a tooth that it recognizes in its own patent. Petitioner itself acknowledges that "the data obtained using the

spectrophotometric approach . . . has been found difficult to implement in practice." *See* U.S. Patent No. 8,208,704, issued on June 26, 2012, to Wong and Milch ("Wong") (EX2006, 3:54-58). "The use of a light scanning component for measuring different spectral components, generally employing a grating or filter wheel, tends to make the spectrophotometric system fairly bulky and complex." *Id.* at 58-61. "This makes it difficult to measure teeth toward the back of the mouth." *Id.* "Attempts to alleviate this problem have not shown great success." *Id.* at 61-64. "To obtain a color mapping of an entire tooth surface requires numerous separate measurements with this approach." *Id.* at 4:4-6. "The image capture process is time-consuming and does not provide consistent results." *Id.* 6-8. "Color mappings can be inaccurate using such an approach, since there can be considerable sensitivity to illumination and image capture angles and probe orientation during the imaging process." *Id. 8-12.*

Even after the effective filing date of the '151 Patent, the art including Babayoff himself recognized that "[a]ssociating color information with three-dimensional objects is not straightforward, particularly when the position information is obtained by using a three dimensional scanning method, while the color information is obtained by using a two dimensional scanning method." EX2003, 2:12-16; *see also* EX2004, 1:31-35. "The problem of conformally mapping the two dimensional color information onto the three dimensional surface

model is difficult and it is common for mismatching of the color with three-dimensional points to occur." EX2003, 2:16-20. "Essentially, where two-dimensional color detectors are used for obtaining the color information, it is difficult to accurately associate color information from the detectors with the correct points on the three dimensional surface model, particularly where relative movement between the object and the device occurs between the acquisition of the three-dimensional topological data and acquisition of the two-dimensional image data." EX2003, 2:20-27.

Accordingly, for the reasons stated above, Petitioner and its expert are simply wrong when they assert that a POSA would have expected the combination of Babayoff and Chu "to work for its intended purpose because Chu describes prior art imaging systems capable of determining tooth shade values from measured color data and known color values of one or more reference tooth shaped values." Petitioner has merely stated the conclusion without supporting explanation or facts. Petitioner has completely ignored the difficulties in associating color information with 3D objects when the position information is obtained by using a 3D scanning method, while the color information is obtained by using a 2D scanning method.

Claims 2, 6, 7, 9-12 and 15 directly or indirectly depend from one of Claims 1, 13 and 14 and thus require the limitations of one of Claims 1, 13 and 14. Petitioner

fails to satisfy its burden with respect to the challenged dependent claims for at least the reasons discussed above with respect to Claims 1, 13 and 14.

Thus, for the reason stated above, Petitioner fails to satisfy its burden with respect to Ground 1.

B. Petitioner Fails to Demonstrate a Reasonable Likelihood of Success That the Petitioner Would Prevail with Respect to at Least One of the Claims Challenged in Grounds 2 and 3

Petitioner fails to demonstrate a reasonable likelihood that the Petitioner would prevail with respect to at least one of the claims challenged in Grounds 2 and 3. Petitioner relies on Graham (Ground 2) for purportedly addressing the additional features of dependent Claim 3. Petitioner relies on Nathaniel (Ground 3) for purportedly addressing the additional features of Claims 15-17. Claims 3 and 15-17 directly or indirectly depend from one of Claims 1, 13 and 14 and thus require the limitations of one of either Claims 1, 13 and 14. Neither Graham nor Nathaniel cures the deficiencies of Babayoff and Chu as discussed above. Thus, Petitioner fails to satisfy its burden with respect to these challenged dependent claims for at least the reasons discussed above with respect to Claims 1, 13 and 14. *See* § V.A.

C. Petitioner Fails to Demonstrate a Reasonable Likelihood That the Petitioner Would Prevail with Respect to at Least One of the Claims Challenged in Ground 4

Petitioner fails to demonstrate a reasonable likelihood that the Petitioner would prevail with respect to at least one of the claims challenged in Ground 4 based

on Babayoff and Inglese for at least the following reasons. First, Petitioner fails to demonstrate that Babayoff, Inglese or any combination thereof discloses all of the limitations of the independent claims. Second, Petitioner fails to demonstrate that a POSA would have been motivated to combine Babayoff with Inglese to arrive at the claimed invention. Third, Petitioner fails to demonstrate that a POSA would have had a reasonable expectation of success in combining Babayoff and Inglese to arrive at the claimed invention.

1. Petitioner Fails to Demonstrate That Babayoff, Inglese or any Combination Thereof Discloses All of the Limitations of the Independent Claims

Petitioner asserts that Babayoff discloses in combination with Inglese the step of determining a tooth shade value. Pet. at 51. However, Petitioner does not specifically describe what Babayoff fails to disclose. Earlier in the Petition, however, Petitioner explicitly states that "it is not apparent that Babayoff discloses determining a tooth shade value for at least one point on the tooth based on the color data c of the corresponding point of the digital 3D representation and on known color values of one or more reference tooth shade values." *Id.* at 21. Thus, as mentioned in § V.A.1., there is no dispute that Babayoff fails to disclose this feature of the claimed invention. Instead, Petitioner relies on Inglese to make up for the deficiencies of the Babayoff. However, like Babayoff and Chu, Inglese fails to

disclose the step for determining a tooth shade value as recited in independent Claims 1, 13, and 14.

Petitioner asserts that Inglese describes "a manner of measuring tooth shade where a sensor receives a measurement signal from the illuminated tooth and that signal is converted into Cartesian x, y, z coordinates in three dimensional shade space where reference points are also defined." Pet. at 51-52. Petitioner further asserts that Inglese discloses that an automatic search is performed where the shade corresponding to the reference point close to the measurement point is established. *Id.* Petitioner further asserts that Inglese discloses that an automatic search is performed where the shade corresponding to the reference point close to the measurement point is established. *Id.* Petitioner repeatedly provides annotated depictions of Fig. 5 of Inglese in support of its assertions. *Id*. at 51, 52, 53. However, Petitioner provides no explanation of how Inglese discloses determining a tooth shade value for at least one point on the tooth based on the color data of the corresponding point of the digital 3D representation and on known color values of one or more reference tooth shade values.

Petitioner's assertions to the three-dimensional shade space disclosed in Fig. 5 of Inglese have nothing to do with a digital 3D representation of a tooth having shade data. As shown in Fig. 5, the coordinates are color coordinates not cartesian 3D XYZ dimensional coordinates and not a 3D representation of a tooth.

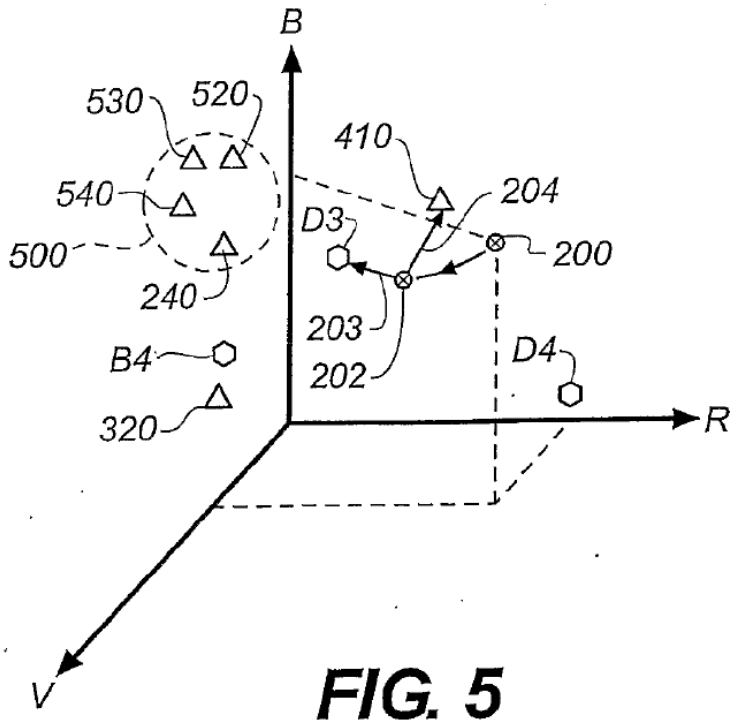
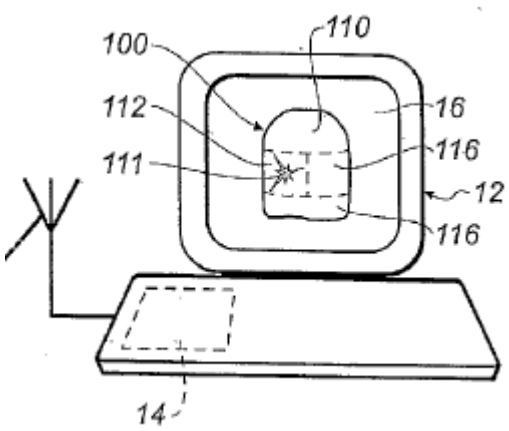


FIG. 5

EX1109, FIG. 5. As shown above, the color coordinates are blue, red, and violet and not Cartesian x, y, z coordinates in three-dimensional geometric space. Nor does Petitioner explain how Inglese describes obtaining a tooth shade value based on a digital 3D representation of a tooth and on known texture values of one or more reference tooth shade values. Inglese does not disclose a 3D representation of a tooth let alone such representation having color or texture.

Like Chu, Inglese discloses obtaining 2D shade data for areas or parts of the tooth making it "possible to prepare a tooth map showing the shade of various parts of the tooth." EX1109, ¶[0040]. This is illustrated in the top portion of Fig. 1

(provided below) which illustrates areas 110, 111, and 116 of the tooth D on a 2D display. *Id*. at ¶[0070].



EX1109, FIG. 1. The "shade of the relevant tooth part 112 can be replaced or compensated for by a shade average calculation according to the shade of the other or neighboring tooth parts 110, 114, 116." *Id.* Inglese does refer to "points" throughout the specification. However, when referring to "points", it is referring to points in the colorspace (not Cartesian x, y, z coordinates in three-dimensional in a geometrical space) which "depends on the one hand on the dental shade guide to which these points correspond, and on the other hand on the choices of color vectors or dimensions that subtend the space." *Id.* at ¶[0046].

Accordingly, no combination of Babayoff and Inglese discloses each of the features of Claims 1, 13, and 14. Neither Babayoff nor Inglese disclose determining a tooth shade value for at least one point on the tooth based on color data of the

corresponding point of the digital 3D representation and on known color values of one or more reference tooth shade values.

2. Petitioner Fails to Demonstrate That a POSA Would Have Been Motivated to Combine Babayoff with Inglese to Arrive at the Claimed Invention

Petitioner essentially incorporates its motivation rationale with respect to Ground 1 in Ground 2 except it replaces Chu with Inglese. In fact, Petitioner expressly acknowledges that it is relying on the same reasoning. The Petition states:

> The teachings of Inglese are thus similar in all relevant respects to the teachings of Chu, discussed *supra* in connection with claim 1. *Id.* Accordingly, ***it would have been obvious to combine Babayoff with Inglese for the same reasons it would have been obvious to combine Babayoff with Chu***.

Pet. at 54-55 (emphasis added). However, as explained above, Petitioner's rationale for combining Chu with Babayoff is faulty. For those same reasons, Petitioner's rationale for combining Inglese with Babayoff is also faulty. *See* § V.A.2.

Petitioner asserts that a POSA would have sought to configure Babayoff's system by replacing Babayoff's ***allegedly manual*** shade matching function with Inglese's automated shade matching function to allow "the appearance of the tooth … [to be] 'freed from the subjectivity part related to the practitioner.'" Pet. at 54.

In support of this assertion, Petitioner submits that Babayoff's shade matching function is limited to a manual operation (*e.g.*, a visual comparison) performed by an operator. Pet. at 54. Specifically, the Petition states:

> ***Indeed, in Babayoff, at the conclusion of the process the user is still left to fabricate the prosthetic from a mold having a certain color.*** … Inglese provides an automated manner of determining that color, and expressly suggests automating that otherwise manual process is advantageous. EX1003, ¶136.

Pet. at 54 (emphasis added). Petitioner and its expert are simply wrong when they assert that Babayoff discloses as part of its method a shade matching function that requires **a manual or visual comparison with a shade guide**.

Babayoff describes an automated method of mapping shade to a prosthesis based upon the shade of ***surrounding teeth***. As discussed above in § V.A.1., Babayoff does not disclose a shade matching function. The only mention of shade matching is in Babayoff's Background of the Invention. *See* § V.A.2. Babayoff uses the shading characteristics of existing teeth to map the shading characteristics of the prosthesis not a shade guide.

As mentioned above in § V.A.2., Babayoff specifically discloses determining shade by (a) providing separate numerical sub-entities each associated with a different one of at least one tooth within said intra-oral cavity; (b) providing a prosthesis entity comprising surface geometrical data, said prosthesis entity being

associated with a desired prosthesis; and *(c) mapping color data from at least one sub entity in step (a) to said prosthesis entity according to predetermined criteria.* EX1105, at 5:33-46. In step (c), the color data, which as explained above is a numerical entity, is manipulated (*e.g.,* mapped) according to predetermined criterion to provide the shading data.

Babayoff mentions that "the choice [of which teeth are to be considered for modelling the shading of the prosthesis] may be made manually (e.g., visually using a display screen and cursor)." However, this description also specifies that the choice may be made "**automatically**" using a "suitable algorithm." EX1105, at 26:39-56. More importantly, the reference to a manual operation relates to picking teeth as a model for shading the prosthesis. There is no mention of the use of a shade guide to determine the shade of the prosthesis because the shade of the prosthesis is determined based on the selected teeth and not a shade guide.

Petitioner asserts that it would have been obvious to a POSA to replace the manual or algorithmic process of shading a restoration using texture data from surrounding teeth, with the automated process of shading a restoration using texture data from reference tooth shade values of a shade guide as taught by Inglese. Pet. at 54. Petitioner asserts that, in Babayoff, at the conclusion of the process the user is still left to fabricate the prosthetic from a mold having a certain color. *Id.* However, Petitioner's assertions are completely conclusory. Petitioner cites to no passage in

Babayoff that supports its assertion that the Babayoff method requires visual inspection or any other manual shade matching function or operation to be performed in preparing a prothesis. This is because Babayoff makes no such mention. *See* EX1105, at 26:8-26:66.

The Babayoff device is completely different and non-analogous to the Inglese device. Babayoff discloses obtaining a 3D model having color. The Inglese device provides 2D color data alone. The Babayoff device obtains color data for points on the tooth. The Inglese device obtains color data for areas on the tooth. The Babayoff device places the color data in the same frame of reference as the X-Y array used for the 3D model. The Inglese device provides color for 2D image areas and there is no frame of reference for points in a geometrical X-Y array. Simply put, the Inglese device does not provide any data that would be useful in the Babayoff device.

Accordingly, for the reasons stated above, Petitioner is wrong when it asserts that a POSA would have sought to configure Babayoff's system by replacing Babayoff's allegedly manual shade matching function with Inglese's automated shade matching function.

3. Petitioner Fails to Demonstrate That a POSA Would Have Had a Reasonable Expectation of Success in Combining Babayoff with Inglese to Arrive at the Claimed Invention

Petitioner asserts that a POSA would have a reasonable expectation of success modifying Babayoff to compare tooth shade with tooth shade guide values, rather

than tooth shade values from the patient's teeth, and would know how to do so. Pet. at 55 (citing EX1003, ¶137.) According to Petitioner, the modification would require nothing more than modifying Babayoff's algorithm to compare measured texture values with known texture values of reference tooth shade values and select the closest match. *Id.* Petitioner is simply wrong.

As mentioned above in § V.A.3., Petitioner has failed to address in the Petition the difficulties in using spectrophotometers to obtain color data of a tooth that it recognizes in its own patent. Petitioner itself acknowledges that "the data obtained using the spectrophotometric approach . . . has been found difficult to implement in practice." *See* EX2006, 3:54-58. "The use of a light scanning component for measuring different spectral components, generally employing a grating or filter wheel, tends to make the spectrophotometric system fairly bulky and complex." *Id.* at 58-61. "This makes it difficult to measure teeth toward the back of the mouth." *Id.* Attempts to alleviate this problem have not shown great success." *Id.* at 61-64. "To obtain a color mapping of an entire tooth surface requires numerous separate measurements with this approach." *Id.* at 4:4-6. "The image capture process is time-consuming and does not provide consistent results." *Id.* at 4:6-8. "Color mappings can be inaccurate using such an approach, since there can be considerable sensitivity to illumination and image capture angles and probe orientation during the imaging process." *Id.* at 4:8-12.

As further mentioned above in § V.A.3., the art recognized that associating color information with 3D objects is not straightforward, particularly when the position information is obtained by using a 3D scanning method, while the color information is obtained by using a 2D scanning method. EX2003, 1:31-45; EX2004, 2:11-27. Like with Ground 1, Petitioner fails to account for differences in methodologies in obtaining data and the resulting data sets. Babayoff's confocal scanning system is configured for providing a color array of X-Y points that is according to the same frame of reference as the X-Y array used for obtaining the 3D entity. *Id.* Inglese, like Chu, makes no mention of associating color data with a 3D model of a tooth or any other object.

Petitioner and its expert make no attempt to explain how one would use the shade guides described in Inglese with the confocal apparatus described in Babayoff. Petitioner and its expert make no attempt to explain how to acquire the data relied upon in Inglese through Babayoff's confocal imaging system.

- There is no explanation how to implement Inglese's 2D image into Babayoff's confocal imaging system.
- There is no explanation how a POSA would have implemented the devices described in Inglese in Babayoff's system such that the 2D color image is injected into the optical axis of Babayoff's confocal

optics without affecting the operation thereof or degrading the 3D image capture.

- There is no explanation how a POSA would have made scans using the devices described in Inglese in quick succession through the optical axis in Babayoff's confocal optics without affecting the operation thereof or degrading the 3D image capture.
- There is no explanation how one might associate a Z-coordinate of Babayoff with the color data obtained by the Inglese device.
- There is no explanation of how a POSA would have Babayoff's processor align the 2D color image parts obtained by the Inglese device with the 3D entity previously created by Babayoff, and then provide color values to the entity at aligned X-Y points.
- There is no explanation of how one would associate an existing shade guide useful with a Inglese's device with the data gathered by Babayoff's confocal imaging system.

Accordingly, Petitioner is wrong when it states that "a POSA would have a reasonable expectation of success modifying Babayoff to compare tooth shade with tooth shade guide values, rather than tooth shade values from the patient's teeth, and would know how to do so." Pet. at 54. Petitioner has merely stated the conclusion without any supporting facts and has completely ignored the difficulties in

associating color information of 3D objects when the position information is obtained by using a 3D scanning method, while the color information is obtained by using a 2D scanning method.

Claims 2, 6, 7, 9-12 and 15 directly or indirectly depend from one of Claims 1, 13 and 14 and thus require the limitations of one of Claims 1, 13 and 14. Petitioner fails to satisfy its burden with respect to the challenged dependent claims for at least the reasons discussed above with respect to Claims 1, 13 and 14.

Thus, Petitioner fails to satisfy its burden with respect to Ground 4.

D. Petitioner Fails to Demonstrate a Reasonable Likelihood That the Petitioner Would Prevail with Respect to at Least One of the Claims Challenged in Grounds 5-6

Petitioner fails to demonstrate a reasonable likelihood that the Petitioner would prevail with respect to at least one of the claims challenged in Grounds 5 and 6. Petitioner relies on Graham (Ground 5) for purportedly addressing the additional features of dependent Claim 3. Petitioner relies on Nathaniel (Ground 3) for purportedly addressing the additional features of Claims 15-17. Claims 3 and 15-17 directly or indirectly depend from one of Claims 1, 13 and 14 and thus require the limitations of one of Claims 1, 13 and 14. Neither Graham nor Nathaniel cures the deficiencies of Babayoff and Inglese discussed above. Petitioner fails to satisfy its burden with respect to these challenged dependent claims for at least the reasons discussed above with respect to Claims 1, 13 and 14. *See* § V.C.

VI. CONCLUSION

Petitioner fails to demonstrate that any of the challenged claims of the '151 Patent are unpatentable. Thus, the Petition should be denied.

Respectfully submitted,

Date: April 17, 2023

/Todd R. Walters/

Todd R. Walters, Esq. (Reg. No. 34,040)
BUCHANAN INGERSOLL & ROONEY PC
1737 King Street, Suite 500
Alexandria, Virginia 22314
Direct Telephone (703) 838-6556
todd.walters@bipc.com
Counsel for Patent Owner

APPENDIX A - LIST OF EXHIBITS

Exhibit No.	Description
1001	U.S. Patent No. 10,695,151
1003	Declaration of Ioannis A. Kakadiaris
1105	U.S Patent No. 7,698,068 ("Babayoff")
1106	Chu et al., "Dental Color Matching Instruments and Systems. Review of Clinical and Research Aspects," Journal of Dentistry, 38 Supp 2:e2-16, 2010 ("Chu")
1107	U.S. Patent Publication No. 2005/0074718 ("Graham")
1109	U.S. Patent Publication No. 2010/0201986 ("Inglese")
1111	U.S. Patent Publication No. 2011/0188726 ("Nathaniel")
2001	Defendants' Opening Claim Construction Brief filed on January 30, 2023, in *3Shape A/S v. Carestream Dental, LLC et al.*, Civ. Action No. 22-cv-01829 (NDGA)
2002	3Shape's Opening Brief on Claim Construction filed on January 30, 2023, in *3Shape A/S v. Carestream Dental, LLC et al.*, Civ. Action No. 22-cv-01829 (NDGA)
2003	U.S. Patent No. 11,418,770, issued on August 16, 2022, to N. Babayoff
2004	U.S. Patent No. 10,363,118, issued on July 30, 2019, to Y. Moalem
2006	U.S. Patent No. 8,208,704, issued on June 26, 2012, to Wong and Milch ("Wong")
2007	G. Sharma "Color fundamentals for digital imaging" Chpt. 1 in Digital Color Imaging Handbook, 127 pgs. (2003)
2008	R. Balasubramanian "Device characterization" Chpt. 5 in Digital Color Imaging Handbook, 128 pgs. (2003)

CERTIFICATE OF COMPLIANCE WITH 37 C.F.R. § 42.24

I hereby certify that the word count for the foregoing Patent Owner's Preliminary Response totals 11,322 words, excluding the parts which are exempted by 37 C.F.R. § 42.24(a).

Respectfully submitted,

Date: April 17, 2023

/Todd R. Walters/

Todd R. Walters, Esq. (Reg. No. 34,040)
BUCHANAN INGERSOLL & ROONEY PC
1737 King Street, Suite 500
Alexandria, Virginia 22314
Direct Telephone (703) 838-6556
todd.walters@bipc.com
Counsel for Patent Owner

CERTIFICATE OF SERVICE

I hereby certify that a true and correct copy of the foregoing **PATENT OWNER'S PRELIMINARY RESPONSE** is being served on counsel for Petitioner by electronic mail this 17th day of April, 2023 as follows:

John T. McKee (johnmckee@quinnemanuel.com)
Richard W. Erwine (richarderwine@quinnemanuel.com)
James M. Glass (jimglass@quinnemanuel.com)
QUINN EMANUEL URQUHART & SULLIVAN, LLP
51 Madison Ave, 22nd Floor
New York, New York 10010

Jeanne M. Gills (jmgills@foley.com)
FOLEY & LARDNER LLP
321 N. Clark Street, Suite 2800
Chicago, IL 60654

Date: April 17, 2023

/Todd R. Walters/
Todd R. Walters, Esq. (Reg. No. 34,040)
BUCHANAN INGERSOLL & ROONEY PC
1737 King Street, Suite 500
Alexandria, Virginia 22314
Direct Telephone (703) 838-6556
todd.walters@bipc.com
Counsel for Patent Owner