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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

3SHAPE A/S and 3SHAPE INC.
Petitioners

v.

ALIGN TECHNOLOGY, INC.
Patent Owner

Case No. IPR2020-00173
Patent 8,102,538

PETITION FOR INTER PARTES REVIEW OF U.S. PATENT NO. 8,102,538 B2 UNDER 35 U.S.C. §§ 311-319 and 37 C.F.R. § 42.100 *et seq*.

TABLE OF CONTENTS

Page

TABLE OF AUTHORITIES

Cases **Page(s)**

Statutes

Rules

I. INTRODUCTION

3Shape A/S and 3Shape Inc. ("Petitioners") request *inter partes* review for Claims 1-4 and 17-19 of U.S. Patent No. 8,102,538 ("the '538 Patent") (Ex.1001) under 35 U.S.C. §§311-319 and 37 C.F.R. §42.100 *et seq*.

II. MANDATORY NOTICES PURSUANT TO 37 C.F.R. § 42.8(a)(1)

A. Real Party-In-Interest

Pursuant to 37 C.F.R. § 42.8(b)(1), Petitioners certify that 3Shape A/S, 3Shape Inc., 3Shape Holding A/S, 3Shape Trios A/S, and 3Shape Poland sp. z.o.o. are real parties-in-interest. Out of an abundance of caution, 3Shape Medical A/S, 3Shape Germany GmbH, 3Shape France SAS, 3Shape Italy SRL, 3Shape S.A.S., 3Shape (Shanghai) Co., Ltd., 3Shape Do Brasil Soluções Tecnologicas Para Saude Ltda, 3Shape Australia Pty Ltd., 3Shape Trios Sociedad Limitade, 3Shape Japan GK, 3Shape Ukraine Ltd., 3Shape (UK branch), SC Investment Company, LLC, Drop Dental LLC, Shenzhen Full Contour Design Company Ltd., Bosques Humedos Del sur Sociedad De Responsabilidad Limitada, Full Contour SRL, Full Contour LLC, 3Shape Medical Equipment Manufacture Shanghai Ltd., 3Shape Korea Ltd., 3Shape Manufacturing US LLC, Clausen Engineering APS, Tais Clausen, Deichmann Media APS, Nikolaj Hoffmann Deichmann, and the individuals listed in Appendix B are also identified as real parties-in-interest, for purposes of compliance with 35 U.S.C. § 312(a)(2).

B. Identification of Related Matters Under 37 C.F.R. § 42.8(b)(2)

The following is a list of any judicial or administrative matters that would affect, or be affected by, a decision in this proceeding:

Align Technology, Inc. v. 3Shape A/S, Civil Action No. 1:18-cv-01950 (D. Del.) (Complaint filed December 11, 2018; Ex.1034) ("the Delaware litigation");

In the Matter of Certain Dental and Orthodontic Scanners and Software, Inv. No. 337-TA-1144 (U.S. International Trade Commission) (Complaint filed December 10, 2018; Ex.1035) ("the ITC investigation");

3Shape A/S and 3Shape Inc. v. Align Technology, Inc., Petition for *Inter Partes* Review of U.S. Patent No. 8,102,538, IPR2019-00174 (to be filed);

U.S. Patent Application No. 16/427,101, filed on May 30, 2019 (Pending);

U.S. Patent Application No. 16/379,657, filed on April 9, 2019 (Pending);

U.S. Patent Application No. 16/373,482, filed on April 2, 2019 (Pending);

U.S. Patent Application No. 16/270,419, filed on February 7, 2019 (Pending);

U.S. Patent Application No. 15/175,267, filed on June 7, 2016 (Pending);

U.S. Patent Application No. 14/755,171, filed on June 30, 2015, which issued as U.S. Patent No. 9,404,740 on August 2, 2016 ("the '740 patent");

U.S. Patent Application No. 14/511,091, filed on October 9, 2014, which issued as U.S. Patent No. 9,101,433 on August 11, 2015 ("the '433 patent");

U.S. Patent Application No. 14/150,505, filed on January 8, 2014, which issued as U.S. Patent No. 8,885,175 on November 11, 2014 ("the '170 patent);

U.S. Patent Application No. 13/868,926, filed on April 23, 2013, which issued as U.S. Patent No. 8,675,207 on March 18, 2014 ("the '207 patent");

U.S. Patent Application No. 13/620,159, filed on September 14, 2012, which issued as U.S. Patent No. 8,451,456 on May 28, 2013 ("the '456 patent");

U.S. Patent Application No. 13/333,351, filed on December 21, 2011, which issued as U.S. Patent No. 8,363,228 on January 29, 2013 ("the '228 patent");

U.S. Patent Application No. 12/379,343, filed on February 19, 2009, which issued as U.S. Patent No. 7,724,378 on May 25, 2010 ("the '378 Patent");

U.S. Patent Application No. 11/889,112, filed on August 9, 2007, which issued as U.S. Patent No. 7,511,829 on March 31, 2009 ("the '829 Patent");

U.S. Patent Application No. 11/154,520, filed on June 17, 2005, which issued as U.S. Patent No. 7,319,529 on January 15, 2008 ("the '529 Patent");

U.S. Provisional Application No. 60/580,109, filed on June 17, 2004; and

U.S. Provisional Application No. 60/580,108, filed on June 17, 2004.

The '207, '456, '228, and '433 patents are involved in the following pending proceedings:

Align Technology, Inc. v. 3Shape A/S, Civil Action No. 1:17-cv-01649 (D. Del.) (Complaint filed November 14, 2017) ("1649 Delaware litigation");

In the Matter of Certain Intraoral Scanners and Related Hardware and Software, Inv. No. 337-TA-1091 (U.S. International Trade Commission) (Complaint filed November 14, 2017) ("1091 ITC investigation");

3Shape A/S and 3Shape Inc. v. Align Technology, Inc., Petition for *Inter Partes* Review of U.S. Patent No. 8,363,228, IPR2019-00154, filed on November 10, 2018 (trial instituted on June 5, 2019);

3Shape A/S and 3Shape Inc. v. Align Technology, Inc., Petition for *Inter Partes* Review of U.S. Patent No. 8,363,228, IPR2019-00157, filed on November 8, 2018 (trial instituted on June 5, 2019);

3Shape A/S and 3Shape Inc. v. Align Technology, Inc., Petition for *Inter Partes* Review of U.S. Patent No. 8,451,456, IPR2019-00155, filed on November 10, 2018 (trial instituted on June 7, 2019);

3Shape A/S and 3Shape Inc. v. Align Technology, Inc., Petition for *Inter Partes* Review of U.S. Patent No. 8,451,456, IPR2019-00159, filed on November 8, 2018 (trial instituted on June 7, 2019);

3Shape A/S and 3Shape Inc. v. Align Technology, Inc., Petition for *Inter Partes* Review of U.S. Patent No. 8,675,207, IPR2019-00156, filed on November 10, 2018 (trial instituted on June 11, 2019);

3Shape A/S and 3Shape Inc. v. Align Technology, Inc., Petition for *Inter Partes* Review of U.S. Patent No. 8,675,207, IPR2019-00160, filed on November 8, 2018 (trial instituted on June 11, 2019); and

3Shape A/S and 3Shape Inc. v. Align Technology, Inc., Petition for *Inter Partes* Review of U.S. Patent No. 9,101,433, IPR2019-00163, filed on November 8, 2018 (trial instituted on June 11, 2019).

C. Lead and Backup Counsel

Pursuant to 37 C.F.R. §§ 42.8(b)(3) and 42.10(a), Petitioners hereby identify its lead and backup counsel as follows:

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Powers of Attorney are being filed concurrently herewith in accordance with 37 C.F.R. § 42.10(b).

D. Service Information Under 37 C.F.R. § 42.8(b)(4)

Petitioners consent to e-mail service at the addresses listed above.

III. PAYMENT OF FEES

The undersigned authorizes the Office to charge Deposit Account No. 02-4800 for fees required by 37 C.F.R. §42.15(a).

IV. REQUIREMENTS UNDER 37 C.F.R. §42.104

A. Grounds for Standing

Petitioners certify that the '538 Patent is available for *inter partes* review under 37 C.F.R. §42.102(a)(2). Petitioners are not barred or estopped from requesting *inter partes* review challenging the claims of the '538 Patent on the grounds identified herein.

This Petition is filed within one year from the date on which Petitioners were served a Complaint by Patent Owner in the Delaware litigation, which asserted infringement of the '538 Patent.

Neither Petitioners nor its privies have received a final written decision under 35 U.S.C. §318(a) regarding any claim of the '538 Patent on any ground that was raised or could have been raised by Petitioners or its privies in any *inter partes* review, post grant review, or covered business method patent review.

B. Challenges Identified and Precise Relief Requested

Petitioners challenge Claims 1-4 and 17-19 of the '538 Patent and request that these claims be found unpatentable for the reasons given below. Petitioners' Grounds for challenging the validity of the claims are as follows:

Ground	References	Basis	Claims
1	Japanese Patent Publication No. 2001-82935 ("Okamoto") (Ex.1003) in view of U.S. Patent No. 5,912,735 ("Xu") (Ex.1026)	§103	1-2

Ground	References	Basis	Claims
2	PCT Publ. No. WO 00/08415 ("Babayoff") (Ex.1004) in view of Okamoto and Xu	§103	1-4, 17-19

C. Prior Art Qualification of Asserted References

The earliest asserted filing date of the '538 Patent is June 17, 2004—the filing date of priority U.S. Provisional Application Nos. 60/580,108 and 60/580,109. Exs.1018-1019.[1] Ex.1024, ¶25.

All asserted references are prior art under 35 U.S.C. §102(b). Okamoto published on March 30, 2001. Xu issued on June 15, 1999. Babayoff published on February 17, 2000.

D. '538 Patent Examination History

The '538 Patent issued from U.S. Application No. 12/770,379, filed on April 29, 2010. In a November 12, 2010 Office Action, the pending claims were rejected as being obvious over claims in the '829 Patent. Ex.1002, 184-189; Ex.1022. A terminal disclaimer was filed on December 3, 2010. *Id*., 178. A Notice of Allowance was issued on January 4, 2011. *Id*., 151-157.

[1]Petitioners do not concede that any challenged claim is entitled to an effective filing date of June 17, 2004.

On April 1, 2011, and April 4, 2011, claim amendments were filed substituting "scanning means" with "optical scanner," without further explanation or argument. *Id*., 137-149, 115-127. In an April 12, 2011 Office Action, the amended claims were rejected as obvious over claims in the '829 Patent. *Id*., 81-86. A terminal disclaimer was filed on August 12, 2011. *Id*., 79. A second Notice of Allowance issued on September 21, 2011. *Id*., 18-24. The '538 Patent issued on January 24, 2012. *Id*., 1. The Examiner made no rejection based on, and did not comment on, the prior art cited in the Grounds presented herein.

E. Related IPR Proceedings

The PTAB instituted trial in seven IPRs filed against the '228, '456, '207, and '433 Patents which belong to the same family as the '538 Patent. Exs.1045-1048. In those IPRs, the PTAB determined that Petitioner demonstrated a reasonable likelihood that it would have been obvious to combine Babayoff and Okamoto. Exs.1045-1048, 35-36. Babayoff and Okamoto are cited herein.

F. Person of Ordinary Skill in the Art ("POSITA")

A POSITA would have at least (1) a bachelor's degree in electrical engineering, optical engineering, or physics (or equivalent course work) and three to four years of work experience in the areas of optical imaging systems and image processing or (2) a master's degree in electrical engineering or physics (or

equivalent course work) with a focus in the area of optical imaging systems and image processing. Ex.1024, ¶27; Ex.1025.

V. CLAIM CONSTRUCTION

Claim terms are interpreted according to *Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005) (en banc), and its progeny. Some of the claim terms of the '538 Patent are disputed in the ITC investigation. Any claim terms not addressed should be interpreted consistent with the *Phillips* standard.

A. "optical scanner" (Claims 1-4 and 17-19)

In the ITC investigation, Patent Owner construed this term to mean "a device that uses light projection and image capture for scanning." Ex.1020, 42.

Petitioners argued that the phrase invokes §112, ¶6, because the phrase "fails to recite sufficiently definite structures and recites function without reciting structure for performing that function." *Williamson v. Citrix Online, LLC*, 792 F.3d 1339, 1349 (Fed. Cir. 2015) (internal citations omitted).

Under a §112, ¶6 interpretation, the phrase should be construed as requiring a structure of a "confocal optical system, including one or more lasers and an image sensor for receiving returned light from a spatial filter," and a function of "providing depth data of the portion." Ex.1020, 42-43. Petitioners advocated for this construction in the ITC investigation and believe this is the correct construction here. *Id*.

In compliance with 37 C.F.R. §42.104(b)(3), the corresponding structure in the specification of the '538 Patent is as described at, for example, 12:60-13:1, 13:43-45, 13:56-62, 14:45-48, 14:59-62, 15:63-65, 16:19-27, 24:18-22, Figs. 1 (main illumination source 31, main optics 41, detection optics 60), 4A (semiconductor laser unit 28, 31, 41, 60). Ex.1024, ¶¶52-60.

Patent Owner also offered a §112, ¶6 construction for this phrase. Ex.1020, 42-44. Patent Owner identified a structure of "a probing member, a light source for providing arrayed illumination along said depth direction; light focusing optics defining one or more focal planes forward said probing member at a position changeable by said optics; a translation mechanism for displacing said focal plane relative to the structure along the depth direction; an image sensor for measuring intensity of light returning from the portion of the three-dimensional structure; and a processor coupled to the image sensor for determining for each region of the three-dimensional structure an in-focus position, and based on the determined in-focus positions, generating data representative of the topology of said portion or equivalents thereof" and a function of "providing depth data of the portion corresponding to a two-dimensional reference array substantially orthogonal to a depth direction." *Id*.

Petitioners alternatively construed the term to mean "laser confocal scanner, operating separately from an imaging means" in the event that the term was not found to invoke §112, ¶6. *Id*., 43.

The ALJ in the ITC investigation construed this term to be "a device that uses light projection to capture data other than color image data." *Id*., 42.

The challenged claims would have been obvious over the asserted prior art under all constructions, each of which is addressed below.

B. "imaging means" (Claims 1-4, 17-19)

In the ITC investigation, both Petitioners and Patent Owner construed this phrase to invoke §112, ¶6. Ex.1020, 58-60. Petitioners identified a structure of "(1) one or more light sources sequentially illuminating the three-dimensional structure with three or more different colored illuminations, optics, and an image sensor; OR (2) a white light source, separate from and in addition to the light source of the optical scanner, optics, and an image sensor" and a function of "providing two-dimensional color image data." *Id*., 58-59.

In compliance with 37 C.F.R. §42.104(b)(3), the corresponding structure in the specification of the '538 Patent is as described at 13:8-13, Figs. 1 (tri-color light source 71 that produces white radiation, delivery optics 73, tri-color sequence generator 74) and 13 (white light illumination system 600). Ex.1024, ¶¶61-66.

Patent Owner offered a §112, ¶6 construction for this phrase, identifying a structure of "white illumination and a color image sensor (*e.g.,* a color CCD) for detecting intensity of the white illuminating radiation after reflection from the portion; or sequential monochromatic illumination (*e.g.,* RGB) and an image sensor (*e.g.,* a CCD) for detecting intensity of the monochromatic illuminating radiation after reflection from the portion; or equivalents thereof" and a function of "providing two-dimensional color image data of the portion associated with the reference array." Ex.1020, 58-60.

The ALJ construed this term to require a structure of "white illumination optics, and a color image sensor (*e.g.,* a color CCD) for detecting intensity of the white illuminating radiation after reflection from the portion; or sequential monochromatic illumination (*e.g.,* RGB), optics, and an image sensor (*e.g.,* a CCD) for detecting intensity of the monochromatic illuminating radiation after reflection from the portion; or equivalents thereof" and a function of "providing two-dimensional color image data of the portion associated with the reference array." *Id*.

The challenged claims would have been obvious over the asserted prior art under all constructions, each of which is addressed below.

C. "wherein the device is configured for maintaining a spatial disposition with respect to the portion that is substantially fixed during operation of the optical scanner and the imaging means" (Claims 1-4, 17-19)

In the ITC investigation, Patent Owner construed this phrase to mean "a movable device where the operation by the optical scanner and the imaging means is at least substantially or effectively simultaneous such that movement (*i.e.,* a change in spatial disposition) can be ignored and depth data and color data correspond to the same reference array." Ex.1020, 64-65.

Petitioners construed this phrase to mean "wherein the device is configured for maintaining a spatial disposition with respect to the portion that is substantially fixed during the ***separate*** operations of the optical scanner and the imaging means." *Id*. at 64 (emphasis added). This construction is informed by the specification, which discloses that the depth data for the object of interest 26 is obtained separately from the color image data for the object of interest 26. Ex.1001, 12:56-13:19; Ex.1024, ¶¶67-70.

The ALJ construed this term to mean "operation by the optical scanner and the imaging means is at least substantially or effectively simultaneous such that movement (*i.e.,* a change in spatial disposition) can be ignored and depth data and color data correspond to the same reference array." Ex.1020, 64-65.

The challenged claims would have been obvious over the asserted prior art under all constructions, each of which is addressed below.

D. "confocal imaging techniques" (Claim 2)

In the ITC investigation, Patent Owner construed this phrase to mean "a technique that uses an optical scanner with the illumination and detection paths sharing the same focus." Ex.1020, 69.

Petitioners argued in the ITC investigation that the phrase should mean "techniques that use point illumination and point detection." This construction is informed by the specification. Ex.1001, 2:58-67, 5:16-44, 9:7-28, 14:59-15:5, 15:51-65. Specifically, the '538 Patent specifies that "confocal imaging techniques" encompass the techniques described in Babayoff. Ex.1001, 1:40-42; Ex.1024, ¶¶71-74.

The ALJ construed this term to mean "imaging techniques characterized by illumination and detection paths with conjugate focal planes." Ex.1020, 69.

The challenged claims would have been obvious over the asserted prior art under all constructions, each of which is addressed below.

VI. PETITIONERS HAVE A REASONABLE LIKELIHOOD OF PREVAILING

The following discussion explains why the challenged claims are unpatentable over the prior art. Ex.1024, ¶4.

A. Claims 1-2 Are Obvious Over Okamoto in View of Xu (Ground 1).

§VI.A. explains where each element of Claims 1-2 is found in the prior art, in light of the claim constructions discussed in §V. §VI.B. explains why Claims 1-2 would have been obvious.

1. Claim 1 (Preamble): A device for determining the surface topology and associated color of at least a portion of a three dimensional structure, comprising:

Okamoto discloses the preamble of Claim 1.[2] Okamoto discloses a device ("3-dimensional measurement device") for determining the surface topology ("information of the 3-dimensional surface shape") and associated color ("color of the measurement target object") of at least a portion of a three-dimensional structure ("measurement target object," "sample w"). Ex.1003, ¶¶[0001], [0008], [0011]-[0012], [0015]-[0025], Fig. 1; Ex.1024, ¶¶40, 78-79.

The device "is provided with a confocal optical system 1 to obtain the 3-dimensional surface shape information that includes sample height." Ex.1003, ¶¶[0015], [0021]. The surface topology is associated with the color of the three-dimensional structure. *Id*., ¶[0031] ("Picture elements of the hatched portions are

[2]Petitioners do not concede that any preamble of the challenged claims is limiting.

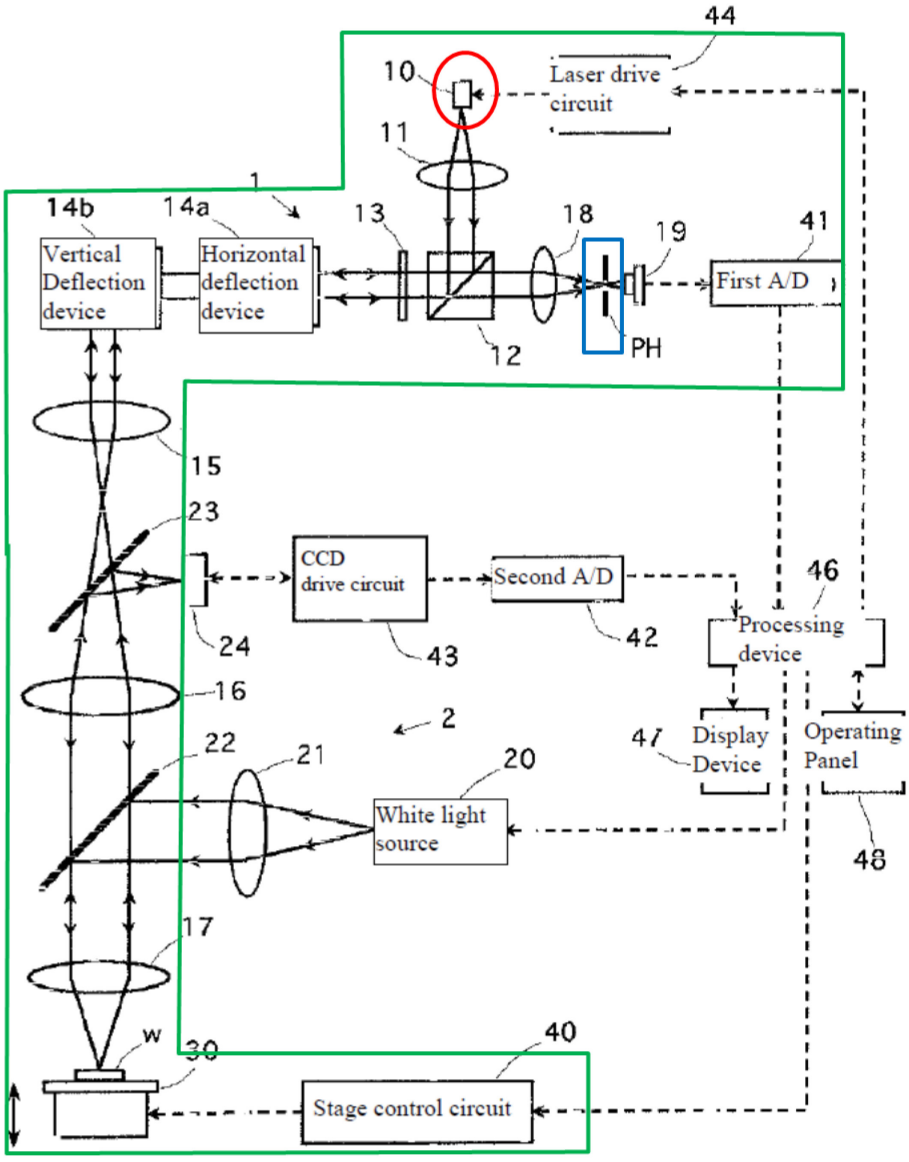
imaged in the XY plane and are ***associated with*** picture elements of the color image [emphasis added]"), Fig. 1; Ex.1024, ¶79.

Xu also discloses the preamble. Xu discloses a device ("laser imaging system") for determining the surface topology ("laser confocal image provides three dimensional information") and associated color ("white light image") of at least a portion of a three-dimensional structure ("object," "sample"). Ex.1026, 1:15-18, 2:38-56, 3:40-50, 5:51-65, 9:44-10:21, Claim 1; Ex.1024, ¶¶42-43, 80.

Xu states that "[t]he white light microscope image may be produced either alone or simultaneously with the live laser image." Ex.1026, 2:50-51. Xu further states that "[s]imultaneous viewing under both white light and laser light is desirable in that ***the white light image provides color information*** of the defect and facilitates locating and identifying the defect, while ***the laser confocal image provides three-dimensional information of the defect***." *Id*., 2:51-56 (emphases added). Xu discloses "a conventional microscope image wherein the natural color is preserved can be obtained, in addition to the laser image." *Id.,* 9:63-65, 9:65-10:21. Thus, Xu associates surface topology and color of at least a portion of a three-dimensional structure. Ex.1024, ¶¶44, 81.

a. [1.1]: optical scanner configured for providing depth data of the portion corresponding to a two-dimensional reference array substantially orthogonal to a depth direction

Okamoto discloses [1.1]. Okamoto discloses an optical scanner ("3-dimensional measurement device" including "confocal optical system 1") configured to provide depth data ("height information") of the portion ("measurement target object," "sample w"). Ex.1003, ¶¶[0008], [0011]-[0012], [0015], [0021]-[0024], Figs. 1, 4; Ex.1024, ¶¶82-83. Okamoto's confocal system is, for example, illustrated in the following annotated figure (green box):



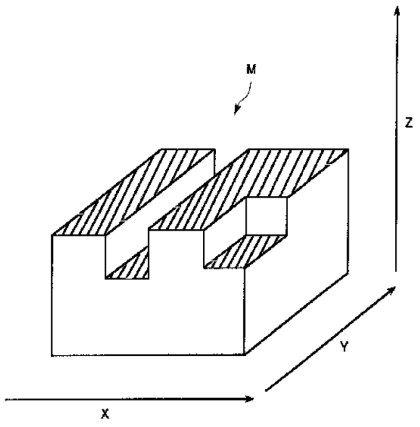
The confocal system includes a semiconductor light source, which emits/projects a red laser beam (red circle). Ex.1003, ¶¶[0016]-[0017]. The laser beam can be biased in the horizontal and vertical directions to different X, Y positions. *Id.*, ¶[0018]. The focal point of the laser can be adjusted by driving the objective lens of the confocal system in the Z-direction. *Id.*, ¶[0019]. When the laser beam impinges on the surface of the target, the laser beam is reflected back through the

confocal system and through a pinhole (blue box) onto a photodiode to convert the returned laser beam into an electrical signal. *Id.,* ¶[0022]. The pinhole/spatial filter acts to block out a significant part of the returned laser beam when out-of-focus, while letting through almost all of the laser beam when in-focus. *Id*. The height position is determined at the point where the measured intensity of the returned laser light beam is at a maximum. *Id*., ¶[0023]; Ex.1024, ¶83.

Okamoto's "confocal optical system 1 comprises light source 10 to irradiate single color light on sample 2 (preferably laser beam)," *i.e.,* project light onto the sample. *Id*. at ¶[0016]. Okamoto's confocal system also includes a "1st photo receptor 19" and a "1st A/D converter 41" that capture images for scanning. Ex.1003, ¶¶[0016], [0020]. Okamoto's confocal system is separate from its color imaging system, which is based on a non-confocal optical system, at least because the confocal system obtains depth data which is distinct from the color image data obtained from the non-confocal system. *Id.,* ¶[0028], Figs. 1, 5. Ex.1024, ¶84.

Thus, Okamoto discloses a "device that uses light projection and image capture for scanning" as understood under Patent Owner's construction, a "device that uses light projection to capture data other than color image data" as understood under the ALJ's construction, and a "laser confocal scanner, operating separately from an imaging means" as understood under Petitioners' plain and ordinary meaning construction (§V.A.). Ex.1024, ¶85.

Okamoto also discloses that the depth data ("height information") corresponds to a two-dimensional reference array ("picture elements of the hatched portions are imaged in the XY plane") substantially orthogonal to a depth ("height" or Z) direction. *Id*., ¶[0031], Fig. 3 (showing hatched portions residing in a plane substantially orthogonal to Z axis, below); Ex.1024, ¶86. Thus, Okamoto discloses the function of "providing depth data of the portion" as identified in Petitioners' construction of "optical scanner" and the function of "providing depth data of the portion corresponding to a two-dimensional reference array substantially orthogonal to a depth direction" as identified in Patent Owner's construction under 35 U.S.C. §112, ¶6 (§V.A.). Ex.1024, ¶89.



Okamoto's light source 10 and laser drive circuit 44, corresponds to the '538 Patent's semiconductor laser unit 28 and main illumination source 31 and "one or more lasers." Ex.1003, Fig. 1; Ex.1024, ¶87. Okamoto's 1st collimated lens 11, beam splitter 12, ¼ wave length plate 13, horizontal biasing device 14a, vertical

biasing device 14b, 1st relay lens 15, 2nd relay lens 16, objective lens 17, image forming lens 18, and pin hole plate PH, corresponds to the '538 Patent's main optics 41 and "a confocal optical system." Ex.1003, Fig. 1; Ex.1024, ¶87. Okamoto's 1st photo receptor 19, corresponds to the '538 Patent's detection optics 60 and "an image sensor for receiving returned light from a spatial filter." Ex.1003, Fig. 1; Ex.1024, ¶87. Thus, Okamoto discloses all structures identified in Petitioners' construction of "optical scanner" under 35 U.S.C. §112, ¶6 (§V.A).

Okamoto's components 10 and 44 (discussed above), correspond to "a light source for providing arrayed illumination along said depth direction." Okamoto's components 11, 12, 13, 14a, 14b, 15, 16, 17, 18, and PH (discussed above), correspond to "light focusing optics defining one or more focal planes forward said probing member at a position changeable by said optics." Okamoto's sample stage 30 and stage control circuit 40, correspond to "a translation mechanism for displacing said focal plane relative to the structure along the depth direction." Okamoto's 1st photo receptor 19, corresponds to "an image sensor for measuring intensity of light returning from the portion of the three-dimensional structure." Okamoto's processing device 46, corresponds to "a processor coupled to the image sensor for determining for each region of the three-dimensional structure an in-focus position, and based on the determined in-focus positions, generating data representative of the topology of said portion or equivalents thereof." Thus,

Okamoto discloses all structures identified in Patent Owner's construction of "optical scanner" under 35 U.S.C. §112, ¶6 (§V.A.).[3] Ex.1024, ¶88.

Xu discloses [1.1]. Xu discloses an optical scanner ("laser imaging system" utilizing "confocal laser scanning") configured to provide depth data ("surface data" or "three dimensional image") of the portion ("object"). Ex.1026, Abstract, 1:51-5, 2:38-43, 8:62-9:39, Fig. 1; Ex.1024, ¶90.

Xu's optical scanner is illustrated in annotated Figure 1 (green box):

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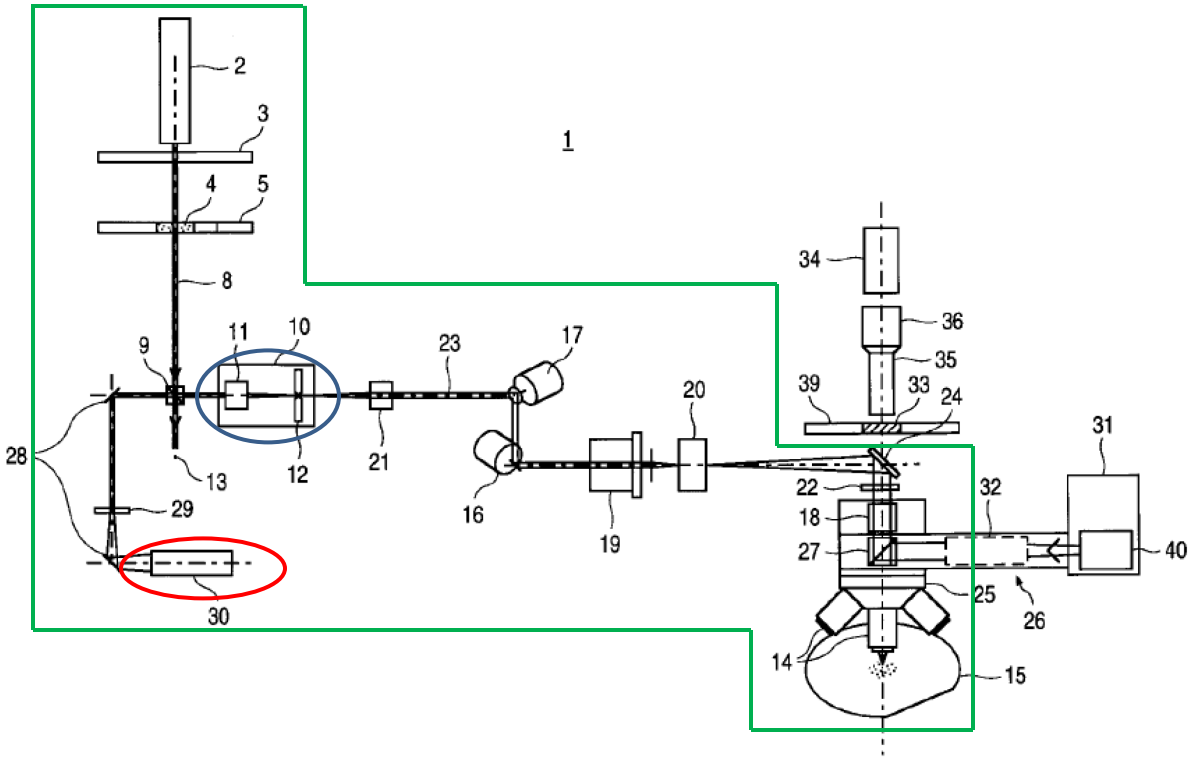
[3] Petitioners' disagree with Patent Owner's §112, ¶6 construction requiring a "probing member" to be a part of the structure of "optical scanner." *Micro Chem., Inc. v. Great Plains Chem. Co.,* 194 F.3d 1250, 1257-58 (Fed. Cir. 1999). The probing member is an optional component according to the '538 specification. Ex.1001, 5:18-20 ("scanning means ***may*** comprise…a probing member with a sensing face [emphasis added]"), 14:42-44, 12:35-37, 19:15-49 (disclosing an embodiment which does not require a probing member). "Probing member" is expressly recited in dependent Claim 3, and is not expressly recited in independent Claim 1 of the '538 Patent. Thus, independent Claim 1—which is broader than dependent Claim 3—does not require a "probing member." Regardless, a "probing member" is expressly taught by Babayoff in Ground 3 (§VI.C.1.a.i.).



Xu explains that its optical scanner uses "the principles of confocal imaging [such that] the laser light striking wafer 15 is scattered and a portion of the light reflected back into objective lens 14, returning through the optical path." Ex.1026, 8:62-65. Xu states "the returning light continues back up the optical path until the light reaches the pinhole aperture 22 of spatial filter 10 [blue circle and is subsequently] imaged on the photodetector 30 [red circle]." *Id.*, 9:3-16. The pinhole/spatial filter acts to block out a significant part of the returned laser beam when out-of-focus, while letting through almost all of the laser beam when in-focus. *Id.*, 9:6-11. Xu's confocal laser scanning system comprises "[a]rgon laser 2 [to] produce[] polarized light as several discrete wavelengths" to irradiate the sample to be scanned, *i.e.,* project light onto the sample. *Id.*, 6:33-7:7. Xu's

optical scanner is separate from its imaging means, at least because Xu's optical scanner obtains depth data which is distinct from the color image data obtained from Xu's imaging means. *Id*., 9:44-10:38 ("The capability for white light imaging, ***in addition to*** the laser imaging described above, is another feature of laser imaging systems [emphasis added]."), 2:39-56; Ex.1024, ¶91.

Thus, Xu discloses "optical scanner" as understood under Patent Owner's construction and the ALJ's construction (§V.A.). Xu also thusly discloses "optical scanner" as understood under Petitioners' plain and ordinary meaning construction (§V.A.). Ex.1024, ¶92.

Xu also discloses that the depth data ("surface data" or "three dimensional image") corresponds to a two-dimensional reference array ("each XY location of the raster scan") substantially orthogonal to a depth ("z") direction. Ex.1026, 9:17-39; Ex.1024, ¶93. For example, Xu explains that

> By measuring the light intensity at ***each XY location of the raster scan***, ***a map of light intensity in the focal plane of the objective lens 14 is constructed***….To ***obtain a three dimensional image***, the optics head works with the fine z-stage control (not shown) to develop an expanded depth-of-field image….After ***each complete raster scan at a particular sample height, the height of the sample is changed using the fine z-stage control***, and a new raster scan performed, as described above, to obtain a map of light intensity in the focal plane of

> objective lens 14 (at the new sample height) by ***measuring the light intensity at each XY location of the raster scan***.

Ex.1026, 9:17-39 (emphases added). Further, the two-dimensional reference array ("map of light intensity") is stored in the memory of the system control computer or analyzed by a surface data processor. *Id*., 9:19-27. Thus, Xu discloses the function of "providing depth data of the portion" as identified in Petitioners' construction of "optical scanner" and the function of "providing depth data of the portion corresponding to a two-dimensional reference array substantially orthogonal to a depth direction" as identified in Patent Owner's construction under 35 U.S.C. §112, ¶6 (§V.A.). Ex.1024, ¶¶93, 96.

Xu's argon laser 2, corresponds to the '538 Patent's main illumination source 31 and "one or more lasers." Ex.1026, Fig. 1; Ex.1024, ¶94. Xu's optional light intensity attenuator 3, spectral line bandpass filter 4, filter wheel 5, polarizing beam splitter 9, spatial filter 10 (including focusing optics 11 and pinhole aperture 12), objective lens 14, X beam scanner 16, Y beam scanner 17, tube lens 18, scan lens 19, field lens 20, collimator lens 21, quarter wave plate 22, beam splitter 24, turret 25, brightfield cube 27, and photodetector diverging lens 29, correspond to the '538 Patent's main optics 41 and "confocal optical system." Ex.1026, Fig. 1; Ex.1024, ¶94. Xu's photodetector 30, correspond to the '538 Patent's detection optics 60 and "an image sensor for receiving returned light from a spatial filter."

Ex.1026, Fig. 1; Ex.1024, ¶94. Thus, Xu discloses all structures identified in Petitioners' construction of "optical scanner" under 35 U.S.C. §112, ¶6 (§V.A).

Xu's argon laser 2, corresponds to "a light source for providing arrayed illumination along said depth direction." Ex.1026, Fig. 1; Ex.1024, ¶95. Xu's components 3-5, 9-12, 14, 16-22, 24-25, 27, and 29 (discussed above), correspond to "light focusing optics defining one or more focal planes forward said probing member at a position changeable by said optics." Ex.1026, Fig. 1. Xu's photodetector 30, corresponds to "an image sensor for measuring intensity of light returning from the portion of the three-dimensional structure." Ex.1026, Fig. 1. Xu's system control computer (or surface data processor), corresponds to "a processor coupled to the image sensor for determining for each region of the three-dimensional structure an in-focus position, and based on the determined in-focus positions, generating data representative of the topology of said portion of equivalents thereof." Ex.1026, 9:19-24. Xu's "fine z-stage control," corresponds to "a translation mechanism for displacing said focal plane relative to the structure along the depth direction".[4] Ex.1026, 9:28-30. Thus, Xu discloses all structures

[4]Petitioners disagree with Patent Owner's §112, ¶6 construction requiring a "probing member" to be a part of the structure of "optical scanner" (fn.5).

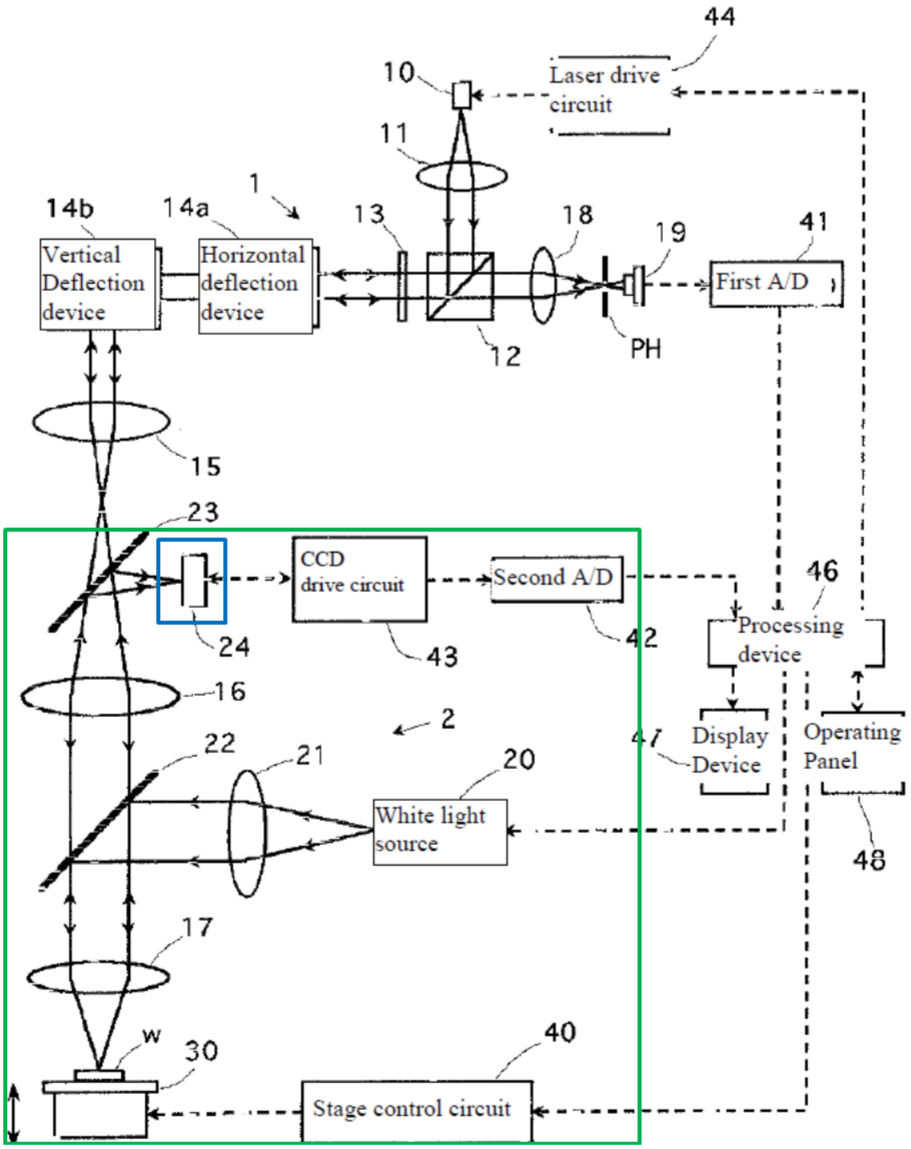
identified in Patent Owner's construction of "optical scanner" under 35 U.S.C. §112, ¶6 (§V.A).

b. [1.2]: imaging means configured for providing two-dimensional color image data of the portion associated with the reference array

Okamoto discloses [1.2]. Okamoto discloses imaging means ("non-confocal optical system 2") configured for providing two-dimensional color image data of the portion ("color of the measurement target object") associated with the reference array ("Picture elements of the hatched portions…are associated with picture elements of the color image"). Ex.1003, ¶¶[0008], [0012], [0015], [0028]-[0031], Figs. 1, 4. Okamoto's color imaging means is based on a non-confocal system and generates two-dimensional color image data that is distinct (*i.e.,* separate) from the depth data obtained by its optical scanner. Ex.1003, ¶[0028]; Ex.1024, ¶¶41, 97-98.

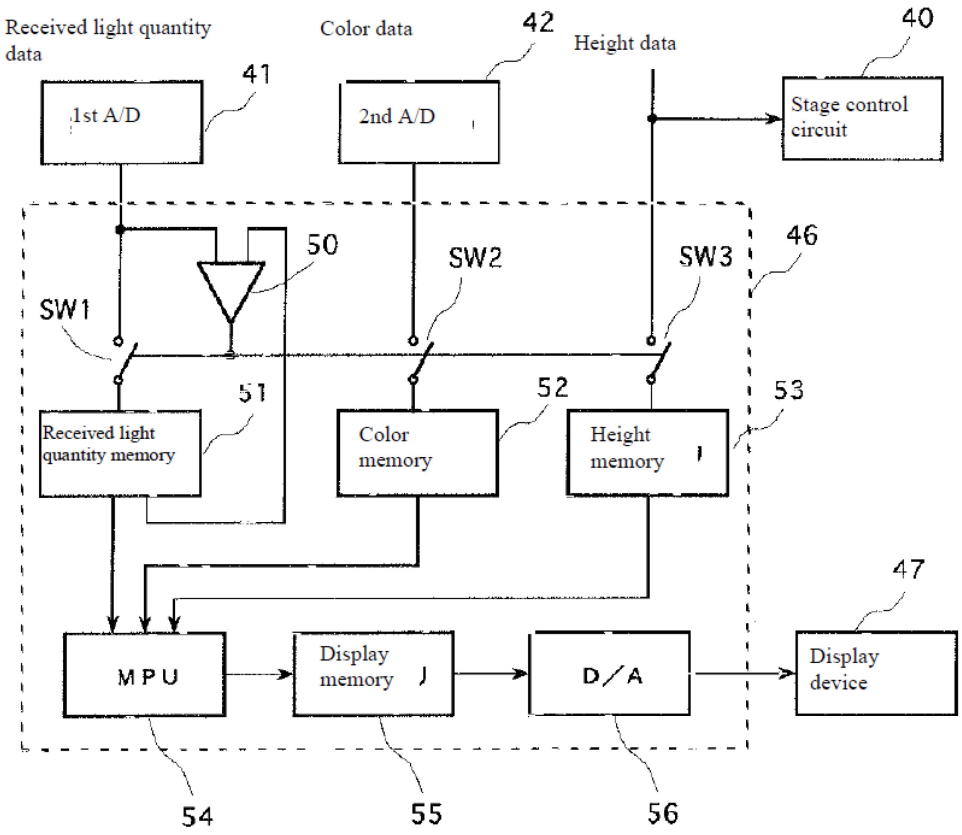
Elements of Okamoto's color imaging means are illustrated in the following annotated figure (green box):

Regardless, a "probing member" is expressly taught by Babayoff in Ground 3 (§VI.C.1.a.i.).



The color imaging means includes a white light source that illuminates the target with a white light. A color CCD is used to capture the color information (blue box). Ex.1003, ¶[0028]; Ex.1024, ¶99. Fig. 4 depicts additional elements of the color imaging means. Okamoto further explains that "light receiving elements for each color R, G, and B may be used instead of a color CCD," indicating that a monochromatic CCD can be used to receive red, green, and blue light. *Id.*

Okamoto's imaging means is configured for providing two-dimensional color image data of the portion "associated with" the reference array because Okamoto discloses that "[c]olor images obtained with the non-confocal system 2 are ***combined*** in a three-dimensional display of the surface profile of the sample obtained by the confocal system 1" and "[p]icture elements of the hatched portions are imaged in the XY plane and are ***associated with*** picture elements of the color image." Ex.1003, ¶¶[0008] (emphases added), [0031], Fig. 3; Ex.1024, ¶100. This is accomplished by correlating the height at each position in the X-Y plane with the corresponding color image data. *Id.,* ¶¶[0031]-[0037]. The association of the color image data with the height data is performed by processing device 46, as illustrated in Fig. 4 of Okamoto. Ex.1024, ¶41. Thus, Okamoto discloses the function of "providing two-dimensional color image data" as identified in Petitioners' construction of "optical scanner" and "providing two-dimensional color image data of the portion associated with the reference array" as identified in Patent Owner's and the ALJ's constructions under 35 U.S.C. §112, ¶6 (§V.B.). Ex.1024, ¶104.

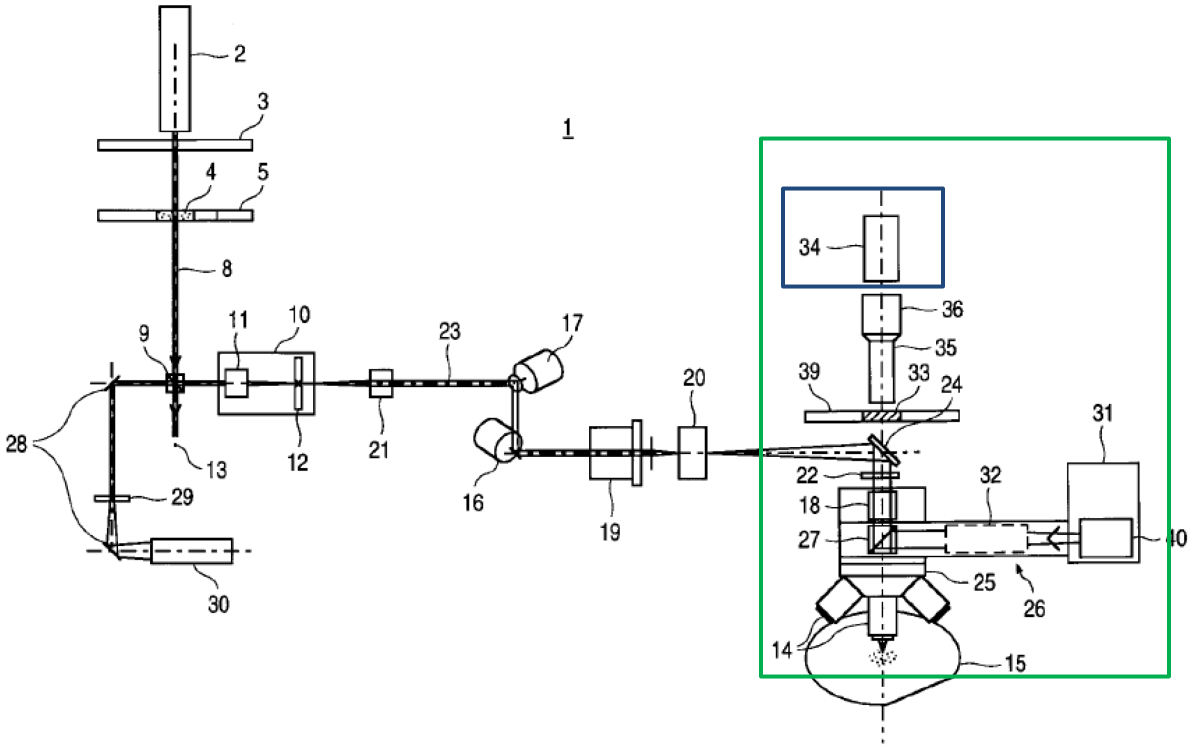


Okamoto's white light source 20 satisfies "a white light source, separate from and in addition to the light source of the optical scanner." Ex.1003, Fig. 1; Ex.1024, ¶101. Okamoto's white light source 20 corresponds to the '538 Patent's white light illumination system 600. Ex.1001, 9:31-35; Ex.1024, ¶102. Okamoto's 2nd relay lens 16, objective lens 17, 2nd collimating lens 21, first half mirror 22, and second half mirror 23, corresponds to the '538 Patent's delivery optics 73 and "optics." Ex.1003, Fig. 1; Ex.1024, ¶102. Okamoto's color CCD 24, corresponds to the '538 Patent's unit 22 comprising detection optics 60 and "an image sensor." *Id.* Thus, Okamoto discloses all structures identified in Petitioners' construction of "imaging means" under 35 U.S.C. §112, ¶6 (§V.B.).

Okamoto's white light source 20, corresponds to "white illumination." Ex.1003, Fig. 1; Ex.1024, ¶103. Okamoto's color CCD 24, corresponds to "a color image sensor for detecting intensity of the white illuminating radiation after reflection from the portion." *Id*. Okamoto's components 16-17 and 21-23 (discussed above), correspond to "optics." *Id*. Thus, Okamoto discloses all structures identified in Patent Owner's and the ALJ's constructions of "imaging means" under 35 U.S.C. §112, ¶6 (§V.B).

Xu discloses [1.2]. Xu discloses imaging means ("white light lamphouse 31"/"video camera 34"/"CCD" combination) configured for providing two-dimensional color image data of the portion ("natural color"/"white light imaging"/"microscope image") associated with the reference array ("map of light intensity"). Ex.1026, 9:17-10:11, Fig. 1; Ex.1024, ¶105. Xu's color imaging means is based on a non-confocal system and, therefore, is separate from Xu's optical scanner. Ex.1026, 9:44-46.

Elements of Xu's color imaging means are illustrated in annotated Fig. 1 (green box):



Xu's color imaging means includes a white light source that illuminates the target with a white light (component 31). A video camera 34 or color CCD is used to capture the color information (blue box). *Id.* Fig. 1 depicts additional elements of the color imaging system. Xu explains that the white light generated in the white light lamphouse 31 "is directed through the vertical illuminator optics 32 positioned within the vertical illuminator 26, and through the BF cube beam splitter 27 whereby the white light is directed through the microscope objective 14 and onto the semiconductor wafer 15." *Id.*, 9:46-52. The white light reflected from the semiconductor wafer "travels backs through the BF cube beamsplitter 27, through the tube lens 18, and through the laser/white light beamsplitter

24…through the holographic notch filter 33…[to] a video camera 34, or charged coupled device (CCD)." *Id*., 9:52-67; Ex.1024, ¶106.

Xu's imaging means is configured for providing two-dimensional color image data of the portion "associated with" the reference array. That is, Xu's two-dimensional color image data is associated with the X-Y location of the raster scan of the optical scanner, at least because the same region of interest is being scanned. *Id*., 9:39-42 ("An X-Y stage control (not shown) is used to position the defect or region of interest in the field of view. The X-Y stage control is then held still while the fine z-stage control is used as described above."), 10:12-21; Ex.1024, ¶107. Thus, Xu discloses the function of "providing two-dimensional color image data" as identified in Petitioners' construction of "optical scanner" and "providing two-dimensional color image data of the portion associated with the reference array" as identified in Patent Owner's and the ALJ's constructions under 35 U.S.C. §112, ¶6 (§V.B.). Ex.1024, ¶109.

Xu's white light lamphouse 31 (including broad spectrum light source 40), corresponds to the '538 Patent's tri-color light source 71 that produces white radiation and tri-color sequence generator 74 and "a white light source, separate from and in addition to the light source of the optical scanner." Ex.1026, Fig. 1; Ex.1001, 9:31-35; Ex.1024, ¶108. Xu's objective lens 14, tube lens 18, quarter wave plate 22, beam splitter 24, turret 25, vertical illuminator 26 (including

vertical illuminator optics 32), brightfield cube beam splitter 27, holographic notch filter 33, and filter wheel 39, correspond to the '538 Patent's delivery optics 73 and "optics." Ex.1026, Fig. 1; Ex.1024, ¶108. Xu's video camera 34 (or CCD), corresponding to the '538 Patent's unit 22 comprising detection optics 60 and "an image sensor." *Id*. Thus, Xu discloses all structures identified in Petitioners' construction of "imaging means" under 35 U.S.C. §112, ¶6 (§V.B).

Xu's white light lamphouse 31 (including broad spectrum light source 40), corresponds to "white illumination." *Id*. Xu's video camera 34 (or CCD), corresponds to "a color image sensor for detecting intensity of the white illuminating radiation after reflection from the portion." *Id*. Xu's components 14, 18, 22, 24, 25-27, 33, and 39 (discussed above), corresponding to "optics." *Id*. Thus, Xu discloses all structures identified in Patent Owner's and the ALJ's constructions of "imaging means" under 35 U.S.C. §112, ¶6 (§V.B).

c. [1.3]: wherein the device is configured for maintaining a spatial disposition with respect to the portion that is substantially fixed during operation of the optical scanner and the imaging means

Okamoto uses a sample stage 30 to maintain the position of sample w. Ex.1003, ¶¶[0039]-[0040], Fig. 5. Okamoto maintains the position of the sample stage 30 (and thus sample w) during the time encompassing the operation of the confocal system 1 (optical scanner) and the non-confocal system 2 (imaging means) when the height data and the color data are obtained. *Id.* After depth and

two-dimensional color image data are obtained at a given sample stage height position, sample stage 30 can be moved in the Z direction (optical axis direction) by stage control circuit 40. *Id*., ¶[0018], Fig. 4. The optical scanner and the imaging means of Okamoto have separate operations because, as discussed concerning elements [1.1] and [1.2], the depth data is obtained separately from the color image data (and subsequently associated with the color image data). The sample stage 30 in Okamoto is not moved during operation of the confocal system 1 (optical scanner) and the non-confocal system 2 (imaging means) at a particular stage height position. There is no substantial change in stage height position from the time at which depth data is obtained to the time at which color data is obtained. Okamoto discloses a movable device (at least the sample stage 30 and sample w are movable). As discussed with respect to element [1.2], Okamoto discloses that depth and color data correspond to the same reference array. Ex.1003, ¶[0008], [0031]-[0037], Figs. 3, 4. Ex.1024, ¶¶110-113. Thus, Okamoto discloses element [1.3] under Petitioners' construction (§V.C.).

However, Okamoto does not expressly disclose that the "operation by the optical scanner and the imaging means is at least substantially or effectively simultaneous such that movement (*i.e.,* a change in spatial disposition) can be ignored" as construed by the ALJ and Patent Owner (partly) (§V.C.). Ex.1024, ¶114.

Xu expressly discloses this limitation. Ex.1024, ¶115. Xu discloses "[a] laser imaging system [that] provides ***contemporaneous, or substantially simultaneous*** laser/white light viewing." Ex.1026, 5:51-65 (emphasis added), 10:12-21 ("[t]he white light microscope image is produced alone or simultaneously with the live laser image"), 3:40-41 ("a laser imaging system that permits true simultaneous laser/white light imaging"), 2:50-51 ("white light microscope image may be produced either alone or simultaneously with the live laser image"), 2:57-60 ("[t]o enable simultaneous viewing under both white light and laser light, a color filter is positioned between the illuminated portion of the wafer and the CCD camera to block the laser light from entering the camera"). The manner by which Xu operates its "optical scanner and imaging means [to be] at least substantially or effectively simultaneous such that movement (i.e., a change in spatial disposition) can be ignored"—as required by the ITC construction of [1.3]—is described in further detail below:

> The reflected white light [from the semiconductor wafer 15] travels back through the BF cube beamsplitter 27, through the tube lens 18, and ***through the laser/white light beamsplitter 24***. With the exception of the wavelength of the spectral line of the laser light, substantially the entire spectrum of the white light is transmitted through holographic notch filter 33.
>
> ***The holographic notch filter transmits substantially all wavelengths except the wavelength of the laser spectral line used to form the***

> ***confocal laser image***. As such, it is selected to complement the spectral line bandpass filter positioned in front of the laser 2. Since substantially the entire visible spectrum is transmitted by holographic notch filter 33, a conventional microscope image wherein ***the natural color is preserved can be obtained, in addition to the laser image***, by using a conventional microscope illuminator 26 and video camera 34, or charge coupled device (CCD).

Id., 9:46-67. Because the laser/white light reflected from the object undergoes beamsplitting, the laser spectral line used to form the confocal laser image is separately and simultaneously obtained alongside the color image by video camera 34 (or CCD).

Thus, the combination of Okamoto and Xu disclose [1.3] as construed by the Patent Owner and the ALJ (§V.C.). Ex.1024, ¶116.

2. Claim 2: A device according to claim 1, wherein the operation of the optical scanner is based on confocal imaging techniques

See Claim 1. The combination of Okamoto and Xu discloses all elements of Claim 2. Ex.1024, ¶117.

Okamoto employs a confocal system for obtaining surface topology information. Ex.1003, ¶¶[0012], [0015]-[0016]; Ex.1024, ¶118. Xu employs a confocal system for obtaining surface topology information (§VI.A.1.a.). Ex.1026, Abstract, 2:50-56, 3:26-32, 3:40-62, 5:24-32, 6:3-7, 6:12-16, 6:26-32, 8:62-64, 9:58-60, Claim 1; Ex.1024, ¶118. Thus, both Okamoto and Xu disclose that the

operation of the optical scanner is based on (1) "techniques that use point illumination and point detection," (2) "a technique…with the illumination and detection paths sharing the same focus," and (3) "imaging techniques characterized by illumination and detection paths with conjugate focal lengths" as understood by Petitioners', Patent Owner's, and the ALJ's constructions, respectively (§V.D.). Ex.1024, ¶119.

B. Why Claims 1-2 Would Have Been Obvious

Claims 1-2 of the '538 Patent would have been obvious over Okamoto in view of Xu. Ex.1024, ¶120.

1. Differences between the claimed invention and the prior art.

Okamoto does not expressly disclose that the "operation by the optical scanner and the imaging means is at least substantially or effectively simultaneous such that movement (*i.e.,* a change in spatial disposition) can be ignored" as that feature of element [1.3] is construed by the Patent Owner and the ALJ (§VI.A.1.c.). Xu discloses this feature (§VI.A.1.c.). Ex.1024, ¶121.

2. A POSITA would have had motivation to combine Okamoto and Xu.

Both Okamoto and Xu disclose devices that include two optical systems: a confocal system for obtaining surface topology and a non-confocal system for obtaining color associated with such surface topology. Ex.1024, ¶122. Both Okamoto and Xu disclose devices that obtain depth and color image data and then

display the same. Ex.1003, Abstract, ¶[0009]; Ex.1026, 10:3-11. Thus, both Okamoto and Xu are in the same field. Ex.1003, ¶¶[0044]-[0045]; Ex.1026, 3:43-46.

Xu demonstrates that, for systems that obtain depth and color data using a movable stage, it is well-known and desirable to operate the optical scanner and imaging means substantially or effectively simultaneously. Ex.1026, 5:51-65 (providing "contemporaneous, or substantially simultaneous" operation of the optical scanner and the imaging means), 10:12-21 ("white light microscope image is produced alone or simultaneously with the live laser image"), 3:40-41 ("a laser imaging system that permits true simultaneous laser/white light imaging, has several distinct advantages"), 2:39-56. Like Okamoto, Xu uses a stage control to hold the stage in a fixed position. *Id*., 9:28-42.

Because mechanical vibrations in the scanning device itself and/or movement of the object to be scanned were recognized as problematic to depth and associated color data acquisition in the art, it would have been obvious to modify Okamoto (in view of Xu) to maintain a spatial disposition with respect to the portion that is substantially fixed during operation of the optical scanner and the imaging means because a POSITA would have sought to reduce positional shifts when collecting scanned data. Ex.1030, 49; Ex.1056, 79-80; Ex.1057, 629-630, Fig. 1, Suppl.2; Ex.1001, 4:61-5:3. The desirability of reducing positional shifts

between scans was known to a POSITA well before the purported invention. Ex.1012, ¶¶[0031]-[0034] (image snapshot time interval limited only by shutter speed and/or flash illumination reduces positional errors); Ex.1010, Abstract (high scanning speeds reduces problems associated with translational confocal microscopes); Ex.1044, Abstract, 9:60-64 (desirability of (quasi)simultaneous channels when imaging using two different imaging techniques or systems); Ex.1024, ¶¶123-125.

Accordingly, a POSITA would have been motivated to modify Okamoto in view of Xu to maintain a spatial disposition with respect to the portion that is substantially fixed during operation of the optical scanner and the imaging means because doing so would reduce errors in portion/sample positional shifts. Ex.1024, ¶125.

The combination of Okamoto and Xu would have been the use of a known technique (operating an optical scanner and imaging means simultaneously as disclosed by Xu) to improve a similar device (systems that obtain depth and color data using a movable stage as disclosed by Okamoto and Xu) in the same way. The combination of Okamoto and Xu would have been the combination of prior art elements according to known methods (operating an optical scanner and imaging means simultaneously as disclosed by Xu) to yield predictable results (reducing

positional shifts between operations of the optical scanner and imaging means as recognized by Exs.1010, 1012, 1044). Ex.1024, ¶126.

3. A POSITA would have had a reasonable expectation of success based on Okamoto, Xu, and knowledge generally available in the art.

A POSITA would have had a reasonable expectation of successfully arriving at the claimed invention because Okamoto and Xu already disclosed a three-dimensional measurement device that obtains and associates color information with depth data. Ex.1024, ¶127. Modifying Okamoto's device such that it maintained a spatial disposition between the portion that is substantially fixed during operation of the optical scanner and the imaging means would only have required routine and conventional methods. For example, Xu suggests the use of common optical components when simultaneously obtaining depth and color image data. Ex.1026, Fig. 1 (both the confocal optical scanner and non-confocal color imaging means share optical paths wherein light rays pass through components 24, 22, 18, 27, and 14, before the laser and white light beams are directed to different detection subsystems.) In fact, Okamoto's exemplary device already shares many optical components between its confocal optical scanner and its non-confocal color imaging means. Ex.1003, Fig. 1 (showing common use of components 22, 17, 16, 23). Further, both Okamoto and Xu describe exemplary embodiments wherein a stage maintains a fixed spatial disposition during optical

scanning and is only moved in the z direction through the use of a programmable motor. Ex.1003, Fig. 1 (component 40); Ex.1026, 9:29-31 (fine z-stage control). Finally, Xu discloses a fairly simple solution for maintaining a spatial disposition between the portion that is substantially fixed during operation of the optical scanner and the imaging means: using a holographic notch filter positioned in front of the white light image capture detector so that both depth and color data can be simultaneously acquired. Ex.1026 at 9:58-60, 9:62-67, Abstract. Thus, only routine and conventional methods would have been required to modify Okamoto in view of Xu.

Further, the prior art included examples of devices wherein the operation of an optical scanner and an imaging means was at least substantially or effectively simultaneous such that movement could be ignored and depth and color data correspond to the same reference array. Ex.1057, 629-630, Fig. 1 (FRET microscopy facilitated the real-time imaging of interactions inside living cells, wherein depth and fluorescence were obtained substantially or effectively simultaneously); Ex.1024, ¶128.

Finally, modifying Okamoto to simultaneously obtain depth and color image data as taught by Xu, was just one of three predictable solutions known to a POSITA: (1) obtain depth data ***before*** color image data; (2) obtain depth data simultaneously ***with*** color image data—as taught by Xu; and (3) obtain depth data

after color image data. A POSITA would have easily arrived at predictable solution (1) by quickly turning on/off the white light source after the laser light source. A POSITA would have easily arrived at predictable solution (3) by quickly turning on/off the white light source before the laser light source. One exemplary alternative to quickly turning on/off the white light source would be to sequentially guide white light and laser light onto the object using a fast micromirror. All of these techniques would have been known to a POSITA at the time of the purported invention. A POSITA would have easily arrived at predictable solution (2) by modifying Okamoto's Fig. 5—"Flow chart showing processing for color three-dimensional display executed with a centralized processing device"—to obtain ***both*** depth and color image data at step #102, store the ***same*** depth and color image depth at step #103, lower the sample stage at step #104, obtain ***both*** depth and color image data at step #105, make a determination as set forth in step #106, and refresh the depth and color image data according to step #107. Ex.1024, ¶129.

For the foregoing reasons, the combination of Okamoto, and Xu render obvious all the recited features of Claim 1. Claim 2 depends from Claim 1, and its additional limitations are disclosed by Okamoto and Xu (§VI.A.2.). The motivations to combine the asserted references and reasonable expectation of

success as discussed for Claim 1 apply equally to Claim 2, which thus would have been equally obvious. Ex.1024, ¶¶130-132.

C. Claims 1-4 and 17-19 Would Have Been Obvious Over Babayoff in View of Okamoto and Xu (Ground 2).

§VI.C. explains where each element of Claims 1-4 and 17-19 is found in the prior art, in light of the claim constructions discussed in §V. §VI.D. explains why Claims 1-4 and 17-19 would have been obvious.

1. Claim 1 (Preamble): A device for determining the surface topology and associated color of at least a portion of a three dimensional structure, comprising:

All elements of the preamble of Claim 1 are disclosed in the combination of Babayoff, Okamoto, and Xu. Ex.1024, ¶135. Okamoto and Xu disclose all elements of the preamble (§VI.A.1.).

Babayoff teaches an "apparatus for non-contact imaging of three-dimensional structures, particularly useful for direct surveying of teeth." Ex.1004, 1:2-4. "A preferred implementation of method and apparatus…are in determining surface topology of a teeth section." *Id*., 5:22-25. "[T]he Z or depth coordinate can be associated with each spot and thus by knowing the X-Y-Z coordinates of each spot the surface topology can be generated." *Id*., 5:4-6, 2:24-4:17, Figs. 1A-1B; Ex.1024, ¶136.

a. [1.1]: optical scanner configured for providing depth data of the portion corresponding to a two-

dimensional reference array substantially orthogonal to a depth direction

All features of [1.1] are disclosed in Babayoff, Okamoto, and Xu. Ex.1024, ¶137. The relevant disclosures of Okamoto and Xu are discussed in §VI.A.1.a.

Babayoff discloses an optical scanner ("apparatus for non-contact imaging of three-dimensional structures, particularly useful for direct surveying of teeth" and "optical device 22") that relies on "confocal focusing an array of light beams." Ex.1004, Title, 1:2-4, 2:24-4:17, 5:22-25, 8:19-12:15, Figs. 1A-1B, Title, Abstract; Ex.1024, ¶138.

The surface topology of the scanned three-dimensional structure is determined by illuminating the surface with an array of incident light beams. Ex.1004, 3:3-4:14. Babayoff teaches that this array of incident light beams is formed by a laser beam that is passed through a grating or a micro lens array to split the laser beam into a plurality of incident light beams. *Id.*, 8:26-9:2. The light beams are then passed through "telecentric main confocal optics." *Id.*, 9:18-24, component 42 of Fig. 4A. The telecentric optics are connected to a motor, which changes the relative position of the distal part of the telecentric optics along the Z-axis. *Id.,* 11:10-13. In other words, the plane at which the light beams are focused can be scanned along the Z-direction. *Id.*, 9:18-24. Thus, Babayoff discloses a device that makes use of light projection. Likewise, Babayoff discloses a device that makes use of one or more lasers. Ex.1024, ¶¶45-46, 139.

When the array of incident light beams impinge on the surface of the three-dimensional structure being scanned, a corresponding array of illumination spots are formed on the surface of the scanned object. Ex.1004, 9:18-24. Each of the illumination spots has a spatially separate X-Y position. *Id.*, 5:1-21. The illumination of the three-dimensional structure with the incident light beams is illustrated in annotated Fig. 1A of Babayoff, elements 48 and 52 (red circle), provided below:

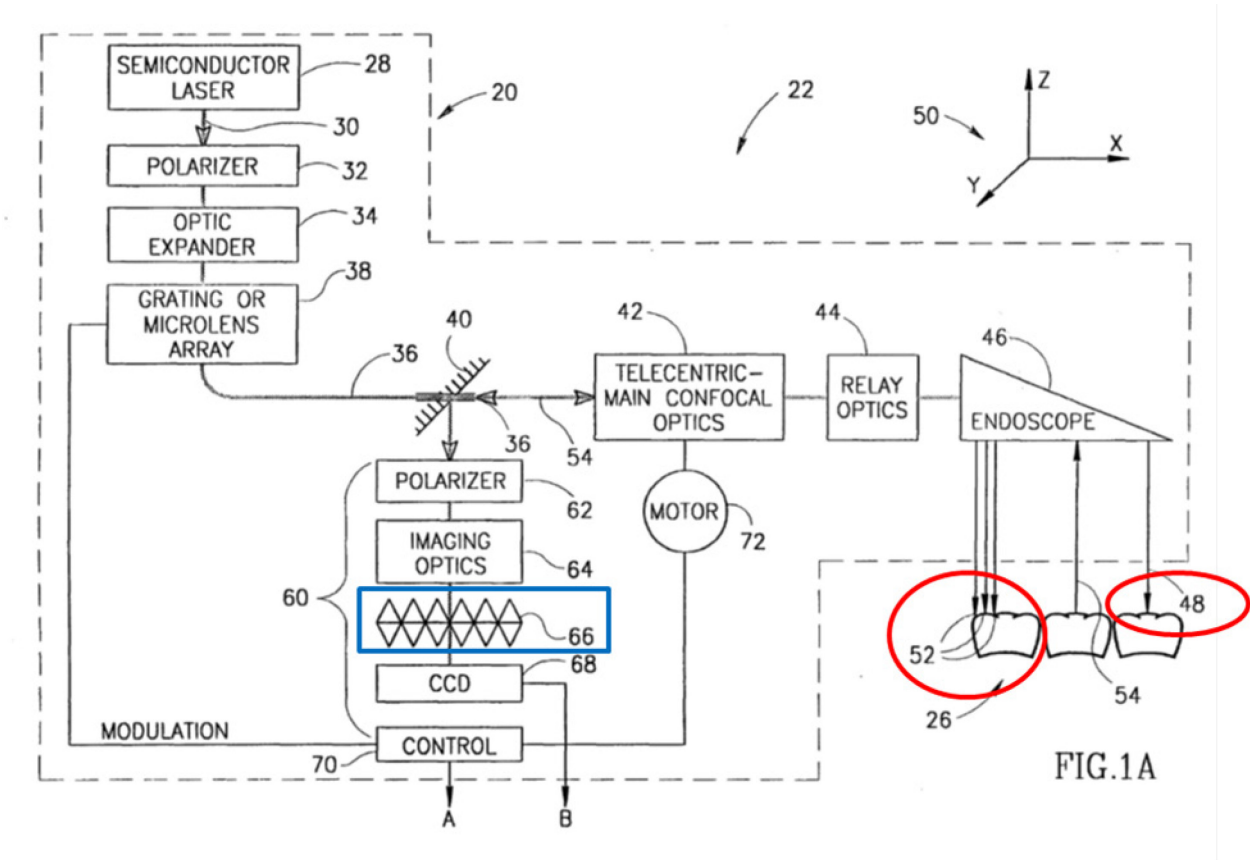


FIG.1A

The illumination spots will be in-focus if the surface of the three-dimensional structure is coincident with the focal plane, otherwise they will be out-of-focus. *Id.* Whether the illumination spot is in-focus or not is determined by measuring the

intensity of the light returned from each illumination spot as the focal plane is shifted along the Z-direction, with maximum light intensity corresponding to the in-focus position. *Id.*, 4:18-29. This is referred to in Babayoff as the "spot-specific position" (SSP). *Id*; Ex.1024, ¶¶47-48.

The intensity of each returned light beam is measured by passing each returned light beam through a corresponding pinhole in pinhole array 66 (blue box). Ex.1004, 10:29-11:5. The pinhole acts as a spatial filter to exclude the out-of-focus light from the CCD image sensor, thereby allowing the pixels in the image sensor to measure the differences in intensity of the return light beam as the focal plane is moved along the Z-direction. *Id.* This is a well-known, conventional implementation of confocal optics. Ex.1024, ¶49.

The surface topology of the scanned three-dimensional structure can be obtained from the maximum measured intensities. Ex.1004, 5:1-6. This is possible because "[t]he SSP for each illuminated spot will be different for different spots"–meaning that the in-focus position of each illuminated spot is independent from the other spots. *Id.* This is also a part of conventional confocal scanning systems. Ex.1024, ¶50.

Babayoff's optical scanner is configured for providing depth data ("the Z or depth coordinate" data) of the portion ("three-dimensional structure") corresponding to a two-dimensional reference array substantially orthogonal to a

depth direction ("the Z or depth coordinate"). *Id*. at 1:2-4, 5:1-10, 6:15-18; Ex.1024, ¶140. Babayoff's optical scanner uses light projection and image capture for scanning. Ex.1004, 3:27-29, 4:7-9; Ex.1024, ¶141. Babayoff teaches that this array of incident light beams is formed by a laser beam that is passed through a grating or a micro lens array to split the laser beam into a plurality of incident light beams. *Id.*, 8:26-9:2.

Thus, Babayoff discloses "a device that uses light projection and image capture for scanning" as understood under Patent Owner's construction and "a device that uses light projection to capture data other than color image data" as understood under the ALJ's construction (§V.A). Babayoff also thusly discloses a "laser confocal scanner, operating separately from an imaging means" as understood under Petitioners' plain and ordinary meaning construction (§V.A). Ex.1024, ¶142.

The '538 Patent explicitly cites Babayoff. Ex.1001, 14:36-44; Ex.1004, 10:55-57, 11:19-23, Fig. 1A (components 28, 30, 32, 34, 38 of Babayoff corresponding to illumination source 31 of '538 Patent; components 40, 42, 44, 46 of Babayoff corresponding to main optics 41 of '538 Patent; component 60 of Babayoff corresponding to detection optics 60 of Babayoff). The '538 Patent explicitly discloses that the optical scanner ("system 20 for confocal imaging") of Babayoff can be used in the system described therein. *Id.* Babayoff explicitly

discloses confocal optics (component 42), one or more lasers (component 28), and an image sensor for receiving returned light through a spatial filter (component 68). Ex.1004, Fig. 1A; Ex.1024, ¶144. Thus, Babayoff discloses all structures identified in Petitioners' construction of "optical scanner" under 35 U.S.C. §112, ¶6 (§V.A).

i. Babayoff discloses the probing member allegedly required under Patent Owner's construction of "optical scanner"

Babayoff discloses components 28, 30, 32, 34, 38, 40, 42, 44, 46 (probing member), 60, 72 (translation mechanism for displacing the focal plane relative to the structure along the depth direction) corresponding to the structures disclosed in the '538 Patent. Ex.1004, Fig. 1A; Ex.1024, ¶¶145-146. Thus, Babayoff discloses all structures identified in Patent Owner's construction of "optical scanner" under 35 U.S.C. §112, ¶6 (§V.A).

The system depicted in Figs. 1A and 1B of Babayoff is virtually identical to the system depicted in Figs. 4A and 4B of the '538 Patent:

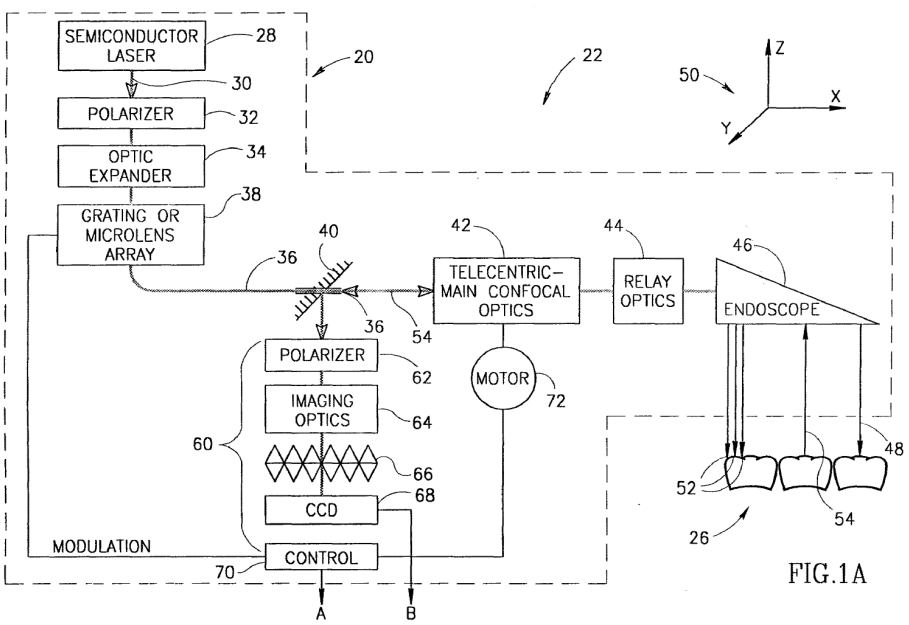


Fig. 1A (Ex.1004)

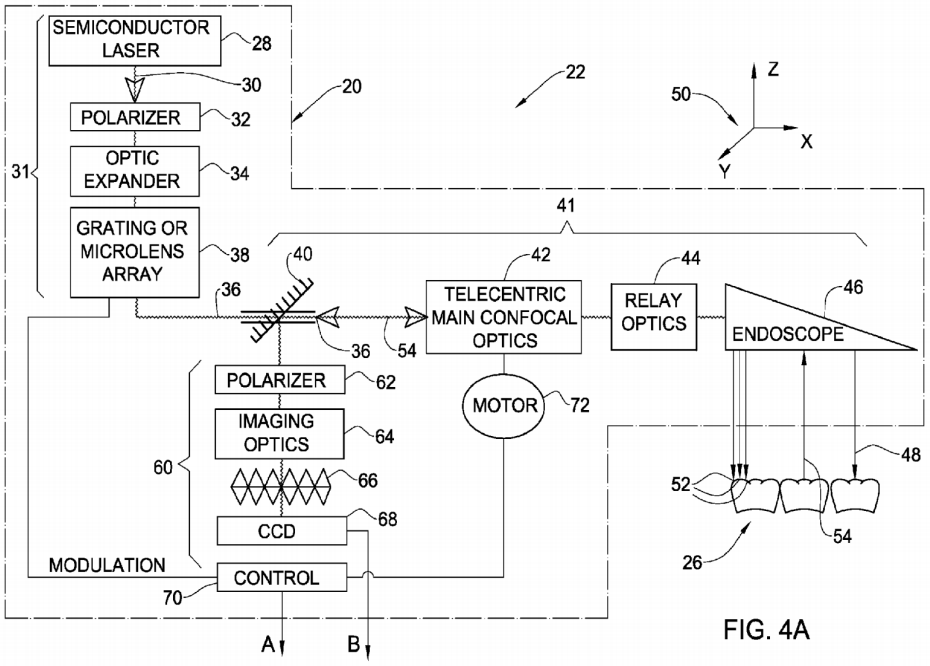


Fig. 4A (Ex.1001)

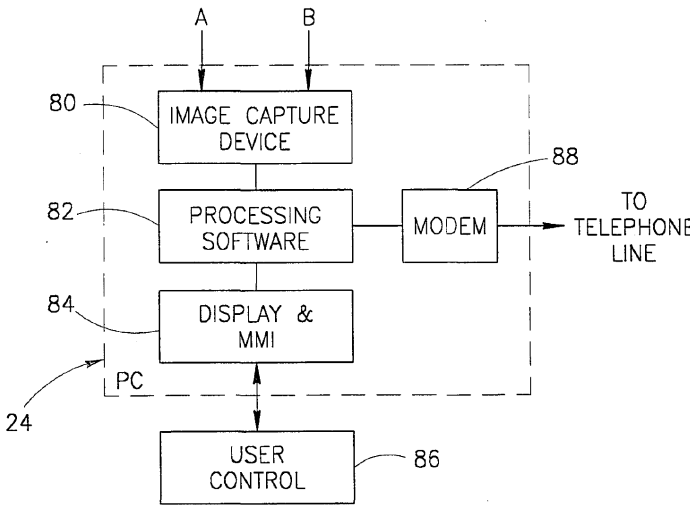


Fig. 1B (Ex.1004)

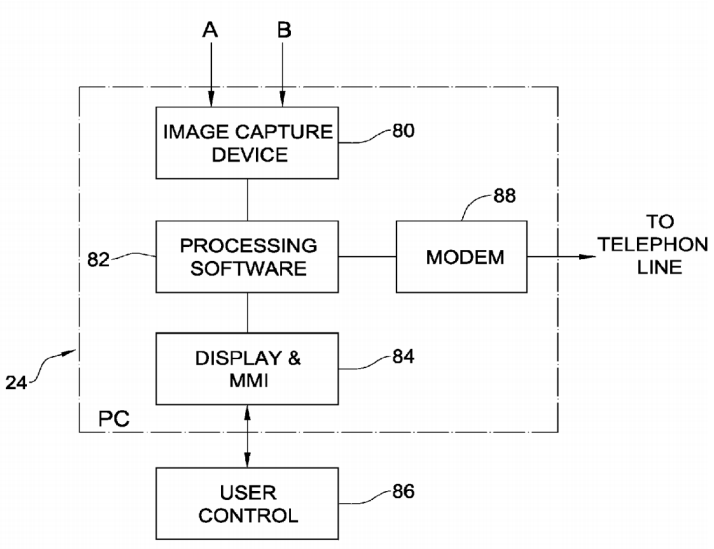


Fig. 4B (Ex.1001)

Babayoff discloses that the depth data ("the Z or depth coordinate" data) corresponds to a two-dimensional reference array substantially orthogonal to a depth direction ("the Z or depth coordinate"). Ex.1004, 6:15-18, 5:2-10; Ex.1024, ¶¶138, 140, 143. Thus, Babayoff discloses the function of "providing depth data of

the portion" as identified in Petitioners' construction of "optical scanner" and the function of "providing depth data of the portion corresponding to a two-dimensional reference array substantially orthogonal to a depth direction" as identified in Patent Owner's construction under 35 U.S.C. §112, ¶6 (§V.A.)

b. [1.2]: imaging means configured for providing two-dimensional color image data of the portion associated with the reference array

The features of [1.2] are disclosed by Okamoto and Xu (§VI.A.1.b.). Ex.1024, ¶147.

c. [1.3]: wherein the device is configured for maintaining a spatial disposition with respect to the portion that is substantially fixed during operation of the optical scanner and the imaging means

All features of [1.3] are disclosed in the combination of Okamoto and Xu (§VI.A.1.c.). Ex.1024, ¶148.

2. Claim 2: A device according to claim 1, wherein the operation of the optical scanner is based on confocal imaging techniques

See Claim 1, *supra*. All elements of Claim 2 are disclosed in the combination of Babayoff, Okamoto, and Xu. Ex.1024, ¶149. The relevant disclosures of Okamoto and Xu are discussed in §VI.A.2.

Babayoff discloses that the operation of the scanning system is based on confocal imaging techniques. Ex.1004, Title, 9:18; Ex.1001, 14:44-46; Ex.1024, ¶150. Thus, Babayoff discloses that the operation of the optical scanner is based

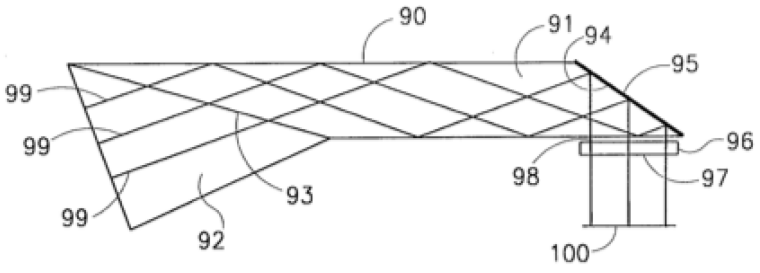
on (1) "techniques that use point illumination and point detection," (2) "a technique…with the illumination and detection paths sharing the same focus," and (3) "imaging techniques characterized by illumination and detection paths with conjugate focal lengths" as understood by Petitioners', Patent Owner's, and the ALJ's constructions, respectively (§V.D.).

3. Claim 3 (Preamble): The device according to claim 2

See Claim 2, *supra*. All elements of the preamble of Claim 3 are disclosed in the combination of Babayoff, Okamoto, and Xu. Ex.1024, ¶151.

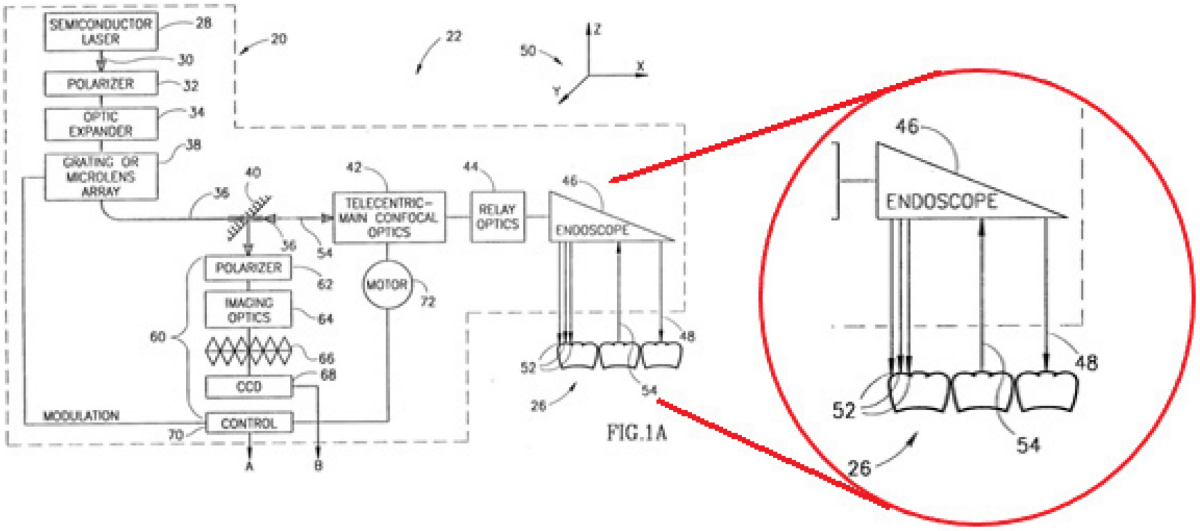
a. [3.1]: wherein the optical scanner comprises: a probing member with a sensing face

The additional features of [3.1] are disclosed in Babayoff. Ex.1024, ¶152. Babayoff discloses a probing member ("probing member 90") with a sensing face ("sensing face 97"). Ex.1004, 3:26, 12:21-13:5, Fig. 2B (below).



b. [3.2]: first illumination means for providing a first array of incident light beams transmitted towards the structure along an optical path through the probing unit to generate illuminated spots on the portion along the depth direction, wherein the first array is defined within the reference array

The additional features of [3.2] are disclosed in Babayoff. Ex.1024, ¶153. Babayoff discloses a first illumination means ("illumination unit") for providing a first array of incident light beams transmitted towards the structure ("for providing an array of incident light beams transmitted towards the structure") along an optical path through the probing unit ("along an optical path through said probing unit") to generate illuminated spots on the portion ("to generate illuminated spots on said portion") along the depth direction (the "Z" direction in Fig. 1A), wherein the first array is defined within the reference array. Ex.1004, 3:27-29, 8:9-13, 10:5-21 (describing an array of incident light beams 48 transmitted toward the three-dimensional dental structure 26), Fig. 1A (annotated below).



c. [3.3]: a light focusing optics defining one or more focal planes forward the probing face at a position changeable by the optics, each light beam having its focus on one of the one or more focal plane

The additional features of [3.3] are disclosed in Babayoff. Ex.1024, ¶154. Babayoff discloses a light focusing optics ("optical device 22") defining one or more focal planes ("the focusing optics defining one or more focal planes") forward the probing face (forward said probing face, "sensing face" of endoscope 46 in Figs. 1A, 2B) at a position changeable by the optics ("in a position changeable by said optics," "changing the relative location of the focal plane"), each light beam (the incident light beams 48") having its focus on one of the one or more focal plane ("each light beam having its focus on one of said one or more focal plane"). Ex.1004, 3:6-10, 8:10-11:21, 10:5-9, 11:10-21, Fig. 2B (depicting probing member 90 with sensing face 97), Fig. 1A, 5:7-10, 14:18-20, 8:10-11:21.

d. [3.4]: a translation mechanism for displacing the focal plane relative to the structure along an axis defined by the propagation of the incident light beams

The additional features of [3.4] are disclosed in the combination of Babayoff, Okamoto, and Xu. Ex.1024, ¶155.

Babayoff discloses "a translation mechanism…for displacing said focal plane relative to the structure along an axis defined by the propagation of the incident light beams." Ex.1004, 4:4-6, Fig. 1A; Ex.1024 at¶156.

Okamoto discloses that sample stage 30 can be moved in the Z direction (optical axis direction) by stage control circuit 40 (§VI.A.1.c). Xu discloses that the height of the sample is changed using the fine z-stage control (§VI.A.1.c). Thus, Okamoto and Xu also disclose a translation mechanism for displacing the focal plane relative to the structure along an axis defined by the propagation of the incident light beams. Ex.1024, ¶157.

e. [3.5]: a first detector having an array of sensing elements for measuring intensity of each of a plurality of light beams returning from the spots propagating through an optical path opposite to that of the incident light beams

All features of [3.5] are disclosed in the combination of Babayoff, Okamoto, and Xu. Ex.1024, ¶158.

Babayoff discloses "a detector having an array of sensing elements for measuring intensity of each of a plurality of light beams returning from said spots

propagating through an optical path opposite to that of the incident light beam." Ex.1004, 4:7-9, Fig. 1A; Ex.1024, ¶159.

Okamoto discloses a "1st photo receptor 19" and a "1st A/D converter 41" that capture images for scanning (§VI.A.1.a.). Xu discloses that "the returning light continues back up the optical path until the light reaches the pinhole aperture 22 of spatial filter 10…[and is subsequently] imaged on the photodetector 30" (§VI.A.1.a.). Thus, Okamoto and Xu disclose a first detector having an array of sensing elements for measuring intensity of each of a plurality of light beams returning from the spots propagating through an optical path opposite to that of the incident light beams. Ex.1024, ¶160.

f. [3.6]: a processor coupled to the detector for determining for each light beam a spot-specific position, being the position of the respective focal plane of the one or more focal planes yielding maximum measured intensity of the returned light beam, and based on the determined spot-specific positions, generating data representative of the topology of the portion

All features of [3.6] are disclosed in the combination of Babayoff, Okamoto, and Xu. Ex.1024, ¶161.

Babayoff discloses "a processor coupled to said detector for determining for each light beam a spot-specific position, being the position of the respective focal plane of said one or more focal planes yielding maximum measured intensity of the returned light beam, and based on the determined spot-specific positions,

generating data representative of the topology of said portion." Ex.1004, 4:10-14; Ex.1024, ¶162.

Okamoto discloses that "the distribution of surface heights of the sample w in the XY plane is obtained [and that this] processing is executed by a processing device 46 using a microcomputer." Ex.1003, ¶[0024]. Okamoto's processing device 46 stores height memory and is coupled to a detector, "first light receiving element 19." *Id*., ¶¶[0024], [0035], Fig. 4. Okamoto displays the distribution of surface heights (surface profile information) on a monitor screen of a display device 47. *Id*., ¶[0025]; Ex.1024, ¶163.

Xu discloses that the "map of light intensity" is stored in the memory of the system control computer or analyzed by a surface data processor (§VI.A.1.a.). Xu discloses that its processor is coupled to a detector and that the light intensity map "may be displayed live on the computer display (not shown) in an appropriate window." *Id*., 9:11-27; Ex.1024, ¶164.

Thus, Okamoto and Xu disclose a processor coupled to the detector for determining for each light beam a spot-specific position, being the position of the respective focal plane of the one or more focal planes yielding maximum measured intensity of the returned light beam, and based on the determined spot-specific positions, generating data representative of the topology of the portion. Ex.1024, ¶165.

4. Claim 4: The device according to claim 3, wherein the first array is arranged to provide depth data at a plurality of predetermined spatial coordinates substantially corresponding to the spatial disposition of the incident light beams

See Claim 3, *supra*. The additional features of Claim 4 are disclosed in Babayoff. Ex.1024, ¶166. Babayoff discloses that the first array ("array of incident light beams transmitted towards the structure") is arranged to provide depth data ("the Z or depth coordinate" data) at a plurality of predetermined spatial coordinates ("different ranges of depth (or Z component) will be scanned") corresponding to the spatial disposition of the incident light beams ("focal plane", "X-Y-Z coordinates" are associated with an X-Y array). Ex.1004, 3:27-29, 5:1-6, 6:15-18; Ex.1024, ¶167.

5. Claim 17 (Preamble): The device according to claim 4, wherein operation of the imaging means is based on any one of the following:

See Claim 4, *supra.* The preamble of Claim 17 recites that operation of the imaging means is based on "any one of the following" three "illuminating" recitations. Okamoto and Xu disclose at least one of the three illuminating recitations and thus satisfy the claimed operation. Ex.1024, ¶¶168-170.

a. [17.1]: illuminating the portion with substantially white illumination radiation, and capturing a color image of the portion, wherein the white illuminating radiation is provided in the form of a second array of incident light beams transmitted towards the portion along an optical path through the probing unit to

generate illuminated spots on the portion along the depth direction, wherein the second array is defined within the reference frame;

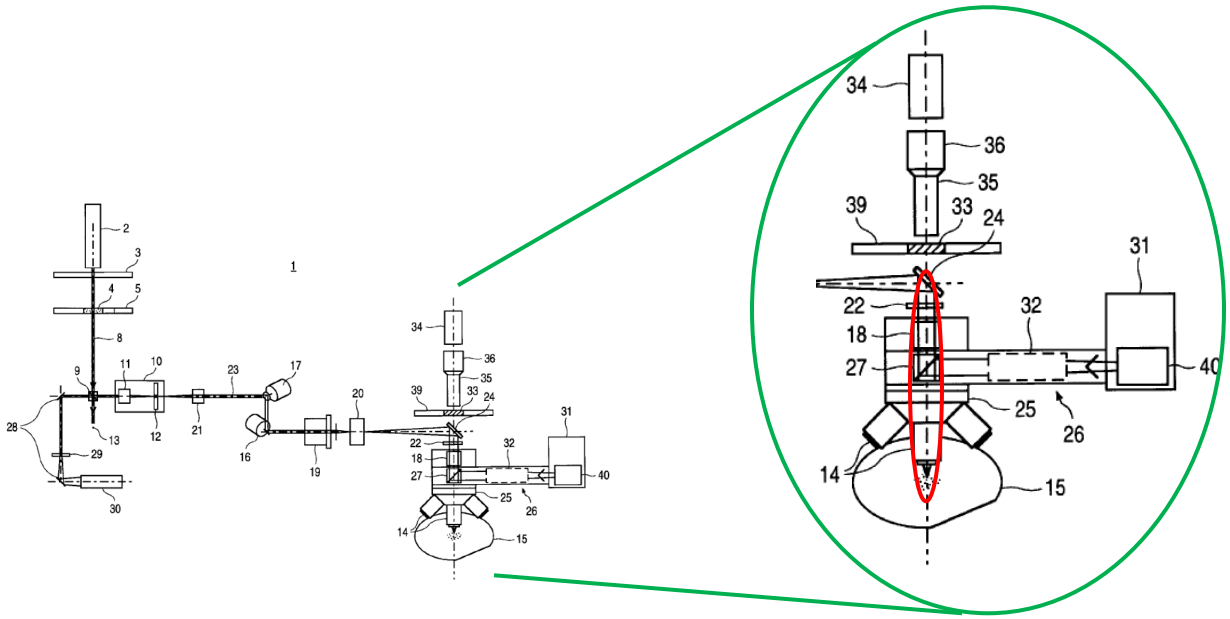
Okamoto describes how the non-confocal system 2 "comprises a white light source 20 that illuminates the sample w with white light (illumination light for color imaging)." Ex.1003, ¶¶[0028], [0044]. Okamoto explains the white light may be provided by a white light lamp, natural light, or indoor light. *Id.*, ¶¶[0029], [0044]. Thus, Okamoto discloses "illuminating the portion with substantially white illumination radiation." Okamoto also discloses "capturing a color image of the portion." *Id*., ¶[0028] ("non-focal optical system 2 comprises…a color CCD 24 used as a color information capture sensor"); Ex.1024, ¶171.

Okamoto explains that the "optical axes of the two optical systems 1 and 2 coincide." *Id.*, ¶[0028]. Thus, Okamoto directs white illuminating radiation ("white light") in the form of a second array of incident light beams towards the portion ("sample w") along the same optical path of confocal system 1. Okamoto discloses that white light "is focused by the objective lens 18 on the surface of the sample w that has been placed on the sample stage 30." *Id*., ¶[0029]. Thus, Okamoto generates illuminated spots on the portion ("sample w") along the depth direction (the coinciding "optical axes of the two optical systems 1 and 2"). Finally, the second array of incident light beams would necessarily be defined

within the reference frame because Okamoto's confocal and non-confocal imaging systems have coinciding optical axes. Ex.1024, ¶172.

Xu discloses that the "white light is generated in the white light lamphouse 31, is directed through the vertical illuminator optics 32 positioned within the vertical illuminator 26, and through the BF cube beam splitter 27 whereby the white light is directed through the microscope objective 14 and onto the semiconductor wafer 15." Ex.1026, 9:46-52. Thus, Xu discloses "illuminating the portion with substantially white illumination radiation." Xu also discloses "capturing a color image of the portion." *Id*., 9:63-67 ("a conventional microscope image wherein the natural color is preserved can be obtained, in addition to the laser image, by using a conventional microscope illuminator 26 and video camera 34, or charge coupled device (CCD)"); Ex.1024, ¶173.

Xu explains that the "white light microscope image is produced alone or simultaneously with the live laser image by video camera 34…which views the sample in white light emitted by the microscope illuminator 26, and inserted into the optical path by beam splitter 24." Ex.1026, 10:12-17. Annotated Fig. 1 of Xu illustrates that the optical paths of the optical scanner ("laser imaging system") and the color imaging means coincide (circled in red):



Thus, Xu discloses transmitting the white illuminating radiation ("white light") in the form of a second array of incident light beams towards the object along the same optical path of the laser imaging system. Xu discloses that the "white light…is directed through the vertical illuminator optics 32 positioned within the vertical illuminator 26, and through the BF cube beam splitter 27 whereby the white light is directed through the microscope objective 14 and onto the semiconductor wafer 15." Ex.1026, 9:46-52. Thus, Xu generates illuminated spots on the portion/object ("semiconductor wafer 15") along the depth direction (the coinciding optic axes of the laser imaging system and the color imaging means). Finally, the second array of incident light beams would necessarily be defined within the reference frame because Xu's confocal and non-confocal imaging systems have coinciding optical axes. Ex.1024, ¶¶174-175.

Okamoto and Xu lack an explicit disclosure regarding "incident light beams transmitted…through the probing unit." However, Babayoff discloses transmitting light beams through a probing unit with respect to an optical scanner. Ex.1004, 3:27-29, 8:9-13, 10:5-21, Fig. 1A; Ex.1024, ¶176.

b. [17.2]: illuminating the portion with substantially white illumination radiation, selectively passing radiation reflected from the portion through a number of color filters, capturing a monochromatic image of the portion corresponding to each the filter, and combining the monochromatic images to create a full color image, wherein the illuminating radiation is provided in the form of a second array of incident light beams transmitted towards the portion along an optical path through the probing unit to generate illuminated spots on the portion along the depth direction, wherein the second array is defined within the reference frame;

As discussed with respect to [17.1], Okamoto describes a non-confocal system 2 that "comprises a white light source 20 that illuminates the sample w with white light (illumination light for color imaging." Ex.1003, ¶¶[0028], [0044]. Thus, Okamoto discloses "illuminating the portion with substantially white illumination radiation." Okamoto explains that the "optical axes of the two optical systems 1 and 2 coincide." *Id.*, ¶[0028]. Thus, Okamoto directs illuminating radiation in the form of a second array of incident light beams towards the portion ("sample w") along the same optical path of confocal system 1. Okamoto discloses that illuminating radiation "is focused by the objective lens 18 on the

surface of the sample w that has been placed on the sample stage 30." *Id*., ¶[0029]. Thus, Okamoto generates illuminated spots on the portion ("sample w") along the depth direction (the coinciding "optical axes of the two optical systems 1 and 2"). Finally, the second array of incident light beams would necessarily be defined within the reference frame because Okamoto's confocal and non-confocal imaging systems have coinciding optical axes. Ex.1024, ¶177.

Okamoto describes how a color CCD 24 is "used as a color information capture sensor." Ex.1003, ¶[0028]. Okamoto also contemplates how "[l]ight receiving elements for each color R, G, B may be used instead of a color CCD 24," *i.e.,* Okamoto contemplates red, green, and blue filtered light reflected from sample w and received by such light receiving elements. *Id.* Okamoto therefore explicitly links the function of the color CCD 24 to that of the color-specific light receiving elements. Because Okamoto contemplates the use of "[l]ight receiving elements for each color R, G, B," Okamoto discloses capturing monochromatic images of the portion corresponding to each color R, G, and B. *Id*. Finally, Okamoto discloses combining and converting color image data to digital values through a "second A/D converter" to create and display full color images of sample w on the monitor screen of the display device 47. *Id*., ¶[0030]; Ex.1024, ¶178.

As discussed in §VI.C.5.a., Okamoto and Xu lack an explicit disclosure regarding "incident light beams transmitted…through the probing unit." Babayoff discloses this limitation (§VI.C.5.a.). Ex.1024, ¶179.

6. Claim 18: The device according to claim 17, wherein the second array is arranged to provide color data at a plurality of spatial coordinates substantially corresponding to the spatial coordinates of the first array.

See Claim 4, *supra.* All elements of Claim 18 are disclosed in the combination of Babayoff, Okamoto, and Xu. Ex.1024, ¶180.

As discussed for Claim 17, Okamoto's and Xu's confocal and non-confocal systems have coinciding optical axes. In the resulting combination of Babayoff, Okamoto, and Xu, the non-confocal system configured to provide color data would provide color data at the spatial coordinates substantially corresponding to the spatial coordinates of the first array. Ex.1024, ¶181.

7. Claim 19: The device according to claim 18, wherein the imaging means comprises:

See Claim 18, *supra*. The additional elements of Claim 19 are disclosed in Okamoto and Xu. Ex.1024, ¶182.

a. [19.1]: white illumination radiation means;

Okamoto describes "a white light source 20 that illuminates the sample w with white light (illumination light for color imaging)." Ex.1003, ¶[0028]. Xu discloses that the "white light is generated in the white light lamphouse 31, is

directed…onto the semiconductor wafer 15." Ex.1026, 9:46-52. Thus, both Okamoto and Xu disclose [19.1]. Ex.1024, ¶183.

b. [19.2]: second detector having an array of sensing elements for measuring intensity of the white illuminating radiation after reflection from the portion.

Okamoto describes how a color CCD 24 is "used as a color information capture sensor." Ex.1003, ¶[0028] Okamoto also contemplates how "[l]ight receiving elements for each color R, G, B may be used instead of a color CCD 24." *Id.* Xu discloses that "the returning light continues back up the optical path until the light reaches the pinhole aperture 22 of spatial filter 10…[and is subsequently] imaged on the photodetector 30." Ex.1026, 9:3-16. Thus, both Okamoto and Xu disclose [19.2]. Ex.1024, ¶184.

D. Why Claims 1-4 and 17-19 Would Have Been Obvious

Claims 1-4 and 17-19 of the '538 Patent would have been obvious over Babayoff in view of Okamoto and Xu. Ex.1024, ¶185.

1. Differences between the claimed invention and the prior art.

The combination of Babayoff, Okamoto, and Xu disclose all features of Claim 1 (§VI.C.1.). While Babayoff does not disclose a device for determining both the surface topology and associated color of at least a portion of a three-dimensional structure, Okamoto and Xu do disclose devices that include two optical systems: a confocal system for obtaining surface topology and a non-

confocal system for obtaining color associated with such surface topology. Ex.1024, ¶186.

2. A POSITA would have had motivation to combine Babayoff, Okamoto, and Xu.

A POSITA would have had a motivation to modify Babayoff to include a color imaging means as described in Okamoto or Xu. Ex.1024, ¶187.

Babayoff discloses that its confocal depth data acquisition system was used in the preparation of dental prostheses. Ex.1004, 2:24-3:2. The desirability of obtaining "the best color match of the dental prosthesis with the patient's teeth" was known in the art. Ex.1007, 1:32-38, 2:18-20; Ex.1038, 4:26-27; Ex.1008, 1:10-19, 2:29-30; Ex.1016, ¶[0004] (recognized need to unambiguously detect teeth and gums and discriminate between diseased and healthy tissue). In light of this desirability, a POSITA would have been motivated to modify Babayoff to include a color imaging system for determining the associated color of the dental structure, as taught by Okamoto and Xu. Ex.1024, ¶¶188-189. This is particularly true given that Okamoto discloses providing accurate color representation so that it is "easier to tell" the "relationship of the site of actual measurement target object and the site of the surface shape that is displayed." Ex.1003, ¶¶[0009], [0046]. Likewise, Xu discloses that "[s]imultaneous viewing under both white light [to obtain color information] and laser light [to provide depth data] is desirable in that the white light image provides color information of the defect and facilitates

locating and identifying the defect, while the laser confocal image provides three-dimensional information of the defect." Ex.1026, 2:51-56.

Okamoto discloses that the processing device 46 (Figs. 1, 4) receives both the three-dimensional surface information (depth data) and color information for the target object, and associates the three-dimensional information with the color information for each pixel of the three-dimensional data to prepare a "color three-dimensional display data," which is "generated from the height data and color data for each picture element in the XY plane." Ex.1003, ¶¶[0031], [0037]. Okamoto discloses that "[b]y coloring the three-dimensional display of the surface profile of a sample [w] in accordance with a two-dimensional color image of the sample in this manner, the correspondence between sample locations and locations in the three-dimensional display will be readily seen." *Id*., ¶¶[0006], [0007], [0033]-[0037], [0046]. Thus, Okamoto discloses that the color image data is associated with picture elements of the depth data, resulting in an ***accurate*** color three-dimensional display image. Ex.1024, ¶190.

Likewise, Xu discloses that its system control computer or surface data processor receives three-dimensional surface information contemporaneously or substantially simultaneously with color information for the target object, and associates the three-dimensional information with the color information for each pixel of the three-dimensional data so that the color information can be "displayed

on a computer display (simultaneous with the laser image, if desired)" after maps of light intensity at each XY location are generated at each focal plane. Ex.1026, 5:51-65, 9:11-27, 10:7-8. Thus, Xu also discloses that the color image data is associated with picture elements of the depth data, resulting in an ***accurate*** color three-dimensional display image. Ex.1024, ¶191.

Accordingly, a POSITA would have been motivated to modify Babayoff in view of Okamoto or Xu to include a color imaging system configured to provide color image data of a dental structure and a processor configured to associate the depth data with the color image data because doing so would enable accurate tooth color determination for further orthodontic purposes. Ex.1024, ¶192.

3. A POSITA would have had a reasonable expectation of success based on Babayoff, Okamoto, Xu, and knowledge generally available in the art.

A POSITA would have had a reasonable expectation of successfully arriving at the claimed invention because Okamoto and Xu already disclosed a three-dimensional measurement device that obtains and associates color information with depth data that could be readily deployed in Babayoff's probe. Ex.1024, ¶193.

Like Babayoff's scanning system, Okamoto and Xu obtain depth data using a confocal system. In view of the similarities between Babayoff's scanning system, Okamoto's confocal system 1, and Xu's confocal laser imaging system, a POSITA would had a reasonable expectation of success in modifying the system of

Babayoff to include an imaging system configured to provide color image data and a processor configured to associate the depth data with the color image data, as taught by Okamoto and Xu. Ex.1024, ¶¶29-36, 194.

Knowledge generally available in the art demonstrated that techniques for "combin[ing] 3D scan data with 2D color photographs to create a 3D model of the teeth" were conventional and routine before the priority date. Ex.1006, ¶[0080], Fig. 4; Ex.1024, ¶¶37, 195. For example, a POSITA would have easily looked to other prior art hand-held dental scanning devices that incorporate an optical scanner for providing depth data, a color image acquisition system, and a processor for associating the depth and color image data. Ex.1016, ¶¶[0001], [0006]-[0016], Fig. 1 (describing an existing hand-held dental three-dimensional scanning device modified to incorporate a color image capturing system, wherein the color data is combined with depth data); Ex.1024, ¶196.

A POSITA was also aware of processors capable of associating different data types and how to place such processors inside handheld devices. Ex.1064, 30-35; Ex.1024, ¶197. As early as 1992, single-chip multimedia video processors (MVP) were readily available. Ex.1039, 54. Such processors were known render both two-dimensional and three-dimensional graphics. Ex.1039, Fig. 3. Such processors were capable of image processing and analysis for image and video signals. Ex.1039, Fig. 3. Such processors were used in medical applications.

Ex.1039, 61. Such processors could be incorporated inside handheld devices useful in medical applications. Ex.1040, 3:29-31, 4:7-10. Thus, the incorporation of such processors inside handheld devices was routine. Ex.1043, 5:50-59.

The specific image processing chips that associated three-dimensional depth and two-dimensional color image data were known to a POSITA by at least 1999. Ex.1041, 1, 5, 7, 12, Fig. 2; Ex.1024, ¶198. These processing chips known for use in medical applications could "perform filtering, false coloring by mapping intensity to color and volume rendering." Ex.1041, 8-9, 13, 18. By the 2000s, many graphics and multimedia processing chips capable of performing the recited associations were commercially available to a POSITA. Ex.1042, 1.

In related IPR2019-00157, IPR2019-00159, and IPR2019-00160 proceedings, Patent Owner alleged problems with combining the Babayoff and Okamoto disclosures, *e.g.,* miniaturization of optical components, aberration errors, light transmission changes, and CCD misalignment. However, the '538 Patent does not discuss, let alone resolve, these purported problems. None of these purported problems demonstrate a lack of reasonable expectation for successfully modifying the device of Babayoff to include a color imaging means and a processor for associating depth and color image data, as explained by Dr. Dianat. Ex.1024, ¶¶200-209 (addressing Ex.1069, Ex.1071-1073 with Ex.1068, Ex.1070, Ex.1050, Ex.1016, Ex.1059, Ex.1038, Exs.1032-1033).

Thus, a POSITA would have had a reasonable expectation of successfully modifying the device and methods of Babayoff to include a color imaging system and a processor for associating depth data with color image data, as taught by Okamoto and Xu. Ex.1024, ¶199. Accordingly, for the foregoing reasons, the combination of Babayoff, Okamoto, and Xu render obvious all the recited features of Claim 1. Ex.1024, ¶210.

Claims 2-4 and 17-19 depend from Claim 1, and their additional limitations are disclosed by Babayoff, Okamoto, and/or Xu (§§VI.C.2.-7). The motivations to combine the asserted references and reasonable expectation of success as discussed for Claim 1 apply equally to Claims 2-4 and 17-19, which thus would have been equally obvious. Ex.1024, ¶211.

VII. OTHER CONSIDERATIONS

A. Any Purported Secondary Considerations Evidence Does Not Overcome the Strong Evidence of Obviousness

Petitioners are not aware of any secondary considerations evidence bearing any nexus to the challenged claims. Any purported evidence of secondary considerations that Patent Owner may present in this proceeding would be insufficient to overcome the strong evidence of obviousness of Claims 1-4 and 17-19. Ex.1024, ¶212. To the extent that Patent Owner presented any such evidence in the ITC investigation, Petitioners are precluded from using or addressing such evidence in this proceeding. Ex.1080; Ex.1081, 23-25.

B. Discretion to Institute

The PTAB should not deny this Petition under §314(a) for two reasons. First, Petitioners have not challenged the '538 Patent in any prior AIA trial proceeding. Based on a review of DocketNavigator® data, the '538 Patent has not been challenged in *any* prior AIA trial proceeding. This Petition is not a "follow-on" petition as was the case in *General Plastic*.

Second, events in the Delaware litigation and ITC investigation do not warrant denial. The statutory framework permits filing within one year of service of a complaint. The Delaware litigation and the ITC investigation are both at early stages and no determinations related to validity have issued. Ex.1015; Ex.1017.

The ITC cannot resolve a challenge to patent validity because the ITC does not have authority to invalidate a patent. *Tex. Instruments Inc. v. Cypress Semiconductor Corp*., 90 F.3d 1558, 1569 (Fed. Cir. 1996); *Wirtgen America, Inc. v. Caterpillar Paving Products Inc.,* IPR2018-01201, Paper 13 (PTAB Jan. 8, 2019) (non-precedential), 12. Further, that this petition challenges a different set of claims (Claims 1-4 and 17-19) than at issue in the ITC investigation (Claims 1-2) weighs in favor of institution. Ex.1034, 11; Ex.1035, 36; *3Shape A/S v. Align Tech., Inc.,* IPR2019-00157, Paper 9 (PTAB Jun. 5, 2019), 38 ("differing claim sets is a factor that weighs against exercise of our discretion under § 314(a) to deny institution based on the ITC investigation."). For these reasons, denying institution

due to the Delaware litigation or the ITC investigation does not promote the efficient administration of justice.

Denial under §325(d) is not warranted when considering the *Becton, Dickinson* factors. None of the references asserted in Grounds 1-2 were considered during prosecution of the '538 Patent, let alone applied in a rejection. Further, during prosecution of ancestral U.S. Application No. 11/889,112, Patent Owner argued that U.S. Patent No. 7,098,435 ("Mueller"; Ex.1037) teaches away from a processing means for associating color data with depth data. Ex.1023, 109-110. In contrast, the obviousness rationales presented herein rely on Okamoto and Xu which explicitly disclose associating depth and color data. Such unpatentability rationales were not before the Examiner during prosecution of the '538 family.

During prosecution of another related application, U.S. Patent No. 6,697,164 ("the '164 Patent"; Ex.1027) (corresponding to Babayoff) was applied in combination with Mueller. Ex.1021, 61-62. This prosecution history also does not warrant denial. First, the rejection based on Mueller and the '164 Patent is not the same or substantially the same as any of the obviousness rationales presented herein (each of which rely on Okamoto or Xu for disclosing associating depth and color data). Second, Patent Owner amended the claims of the related application to recite allowable subject matter (which is not recited in the claims of the '538

Patent). Patent Owner did not present any argument traversing the rejection based on Mueller in view of the '164 Patent. *Id*.

VIII. CONCLUSION

Since Petitioners have shown Claims 1-4 and 17-19 of the '538 Patent to be *prima facie* obvious, Petitioners have shown a likelihood of success on the merits. Therefore, this Petition should be granted, and the Board should institute trial.

Respectfully submitted,

Date: December 9, 2019

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APPENDIX A - LIST OF EXHIBITS

EXHIBIT	DESCRIPTION
1001	U.S. Patent No. 8,102,538, issued on January 24, 2012 to Noam Babayoff ("the '538 Patent")
1002	File History of U.S. Patent Application No. 12/770,379, filed on April 29, 2010 (U.S. Patent No. 8,102,538)
1003	Japanese Patent Publication No. 2001-82935 ("Okamoto"), published on March 30, 2001, with Certified English Translation
1004	PCT International Publication No. WO 00/08415, published on February 17, 2000 ("Babayoff")
1005	U.S. Patent No. 6,263,233, issued on July 17, 2001 to James M. Zavislan and Jay M. Eastman ("Zavislan")
1006	U.S. Patent Application Publication No. 2004/0197727, published on October 7, 2004 ("Sachdeva")
1007	U.S. Patent No. 6,575,751, issued on June 10, 2003 to Lehmann *et al.* ("Lehmann")
1008	U.S Patent No. 5,766,006, issued on June 16, 1998 to Murljacic ("Murljacic")
1009	U.S. Patent No. 3,013,467, issued on December 19, 1961 to M. Minsky ("Minsky")
1010	Cha, S. *et al., 3D profilometry using a dynamically configurable confocal microscope*, 3640 IS&T/SPIE CONFERENCE ON THREE-DIMENSIONAL IMAGE CAPTURE AND APPLICATIONS II 246-253 (Jan. 1999)
1011	U.S. Patent No. 5,754,298, issued on May 19, 1998 to Robert A. Falk ("Falk")
1012	U.S. Patent Application Publication No. 2002/0057438, published on May 16, 2002 ("Decker")

EXHIBIT	DESCRIPTION
1013	Kari Pulli, *Surface Reconstruction and Display from Range and Color Data* (Dec. 2, 1997) available at UMI Microform No. 9819292 (1998)
1014	U.S. Patent No. 5,864,640, issued on January 26, 1999 to John Miramonti and F. Mueller ("Miramonti")
1015	PACER Docket Sheet, *Align v. 3Shape*, Civ. Action No. 1:18-cv-01950 (downloaded on November 25, 2019)
1016	European Patent No. 0837659 B1 ("Franetzki"), published on November 24, 1999, with Certified English Translation
1017	EDIS Document Filing Report In the Matter of: Certain Dental and Orthodontic Scanners and Software, ITC Inv. No. 337-TA-1144 (downloaded on November 26, 2019)
1018	U.S. Provisional Application No. 60/580,108, filed on June 17, 2004
1019	U.S. Provisional Application No. 60/580,109, filed on June 17, 2004
1020	Order No. 36: Construing Certain Terms of the Asserted Claims of the Patents at Issue (*Markman* Claim Construction) in ITC Investigation No. 337-TA-1144, October 1, 2019
1021	File History of U.S. Patent Application No. 09/775,298, filed on February 1, 2001 (U.S. Patent No. 6,697,164)
1022	U.S. Patent No. 7,511,829, issued on March 31, 2009 to Noam Babayoff ("the '829 patent")
1023	File History of U.S. Patent Application No. 11/889,112, filed on August 9, 2007 (U.S. Patent No. 7,511,829)
1024	Declaration of Sohail Dianat
1025	*Curriculum Vitae* of Sohail Dianat

EXHIBIT	DESCRIPTION
1026	U.S. Patent No. 5,912,735 ("Xu")
1027	U.S. Patent No. 6,697,164, issued on February 24, 2004 to N. Babayoff *et al.* ("the '164 Patent")
1028	Paddock, S.W., *Confocal Laser Scanning Microscopy*, 27 BIOTECHNIQUES 992-1004 (1999).
1029	Paddock, S.W., *Confocal Reflection Microscopy: The "Other" Confocal Mode*, 32(2) BIOTECHNIQUES 274-278 (2002).
1030	Cogswell, C.J. *et al., High-resolution, multiple optical mode confocal microscope: I. System design, image acquisition and 3D visualization*, 2184 SPIE 48-54 (1994).
1031	Constans, A., *The Confocal Microscope*, 18(22) THE SCIENTIST 32-33 (2004).
1032	Cogswell, C.J. *et al., Colour confocal reflection microscopy using red, green and blue lasers*, 165 J. MICROSCOPY 103-117 (1992).
1033	Hibbs, A.R., *Confocal Microscopy for Biologists*, Appx. 1, 355-443 (2004)
1034	Complaint filed on December 11, 2018, *Align v. 3Shape*, Civ. Action No. 1:18-cv-01950
1035	Complaint filed on December 10, 2018, *In the Matter of: Certain Dental and Orthodontic Scanners and Software*, ITC Inv. No. 337-TA-1144
1036	Rajadhyaksha, M., *Confocal Reflectance Microscopy: Diagnosis of Skin Cancer Without Biopsy?*, SYMP. FRONT. OF ENG. (1999).
1037	U.S. Patent No. 7,098,435, issued on August 29, 2006 to F. Mueller *et al.* ("Mueller")

EXHIBIT	DESCRIPTION
1038	U.S. Patent No. 7,099,732, issued on August 29, 2006 to Z. Geng ("Geng '732")
1039	Guttag, K. *et al., A Single-Chip Multiprocessor For Multimedia: The MVP*, 12(6) IEEE COMPUTER GRAPHICS & APPLICATIONS 53-64 (1992)
1040	European Publication No. 0 665686 A2, published on August 2, 1995
1041	Gove, R.J., *Image Processing Equipment*, JOHN WILEY & SONS, INC., Dec. 27, 1999
1042	National Semiconductor Corporation, LM9704 Real Time Digital Image Processor Datasheet, October 2002
1043	U.S. Patent No. 5,690,486, issued on November 25, 1997 to Zigelbaum
1044	U.S. Patent No. 6,769,769, issued on August 3, 2004 to Podoleanu *et al.*
1045	*3Shape A/S and 3Shape Inc. v. Align Tech., Inc*., IPR2019-00157, Paper 9 (PTAB June 5, 2019)
1046	*3Shape A/S and 3Shape Inc. v. Align Tech., Inc*., IPR2019-00159, Paper 9 (PTAB June 7, 2019)
1047	*3Shape A/S and 3Shape Inc. v. Align Tech., Inc*., IPR2019-00160, Paper 9 (PTAB June 11, 2019)
1048	*3Shape A/S and 3Shape Inc. v. Align Tech., Inc*., IPR2019-00163, Paper 9 (PTAB June 11, 2019)
1049	Number not used.
1050	U.S. Patent No. 4,575,805, issued on March 11, 1986 to W. Moermann *et al.* ("Moermann")
1051-1055	Numbers not used.

EXHIBIT	DESCRIPTION
1056	Jovanovski, V. and Lynch, E., *Analysis of the Morphology of Oral Structures from 3-D Co-Ordinate Data*, 17 ASSESSMENT OF ORAL HEALTH 73-129 (2000)
1057	Sekar, R.B. and Periasamy, A., *Fluorescence resonance energy transfer (FRET) microscopy imaging of live cell protein localizations*, 160(5) J. CELL. BIOL. 629-633 (2003) and Online Supplemental Material
1058	Number not used.
1059	U.S. Patent No. 6,594,539, issued on July 15, 2003 to Jason Z. Geng
1060-1063	Numbers not used.
1064	Ex.2001 filed in IPR2019-00154 against U.S. Patent No. 8,363,228 ("Declaration of Dr. Chandrajit L. Bajaj, Ph.D. In Support of Patent Owner's Preliminary Response")
1065-1067	Numbers not used.
1068	Lieber, C.A. et al., Handheld confocal Raman microspectrometer for in-vivo skin cancer measurement, 5321 Proc. Of SPIE 10-16 (2004)
1069	Bareau, J. and Clark, P.P., The Optics of Miniature Digital Camera Modules, 6342 SPIE-OSA 0001-11 (2006)
1070	Fairchild CCD Imaging, CCD: The Solid State Imaging Technology Product Catalog, Palo Alto, CA (1981)
1071	Reardon, P.J. and Chipman, R.A., *Maximum power of refractive lenses: a fundamental limit*, 15(23) OPTICS LETTERS 1409-1411 (1990)
1072	Walther, A., *The Perils of Symmetry*, 554 PROC. SPIE 351-355 (1986)

EXHIBIT	DESCRIPTION
1073	W.J. Smith, Modern Lens Design, (2nd ed. 2005)
1074	Tiziani, H.J. *et al., Confocal principle for macro- and microscopic surface and defect analysis*, 39(1) OPTICAL ENGINEERING 32-40 (2000)
1075	U.S. Patent No. 5,784,434, issued on July 21, 1998 to Y.-R. Shieh
1076	Leith, E.N. *et al., Image deblurring using diffraction gratings*, 5(2) OPTICS LETTERS 70-72 (1980)
1077	Wang, G. *et al., Spiral CT Image Deblurring for Cochlear Implantation*, 17(2) IEEE TRANSACTIONS MEDICAL IMAGING 251-262 (1998)
1078	U.S. Patent No. 5,307,175, issued on April 26, 1994 to N.J. Seachman
1079	Yang, G.G. and Leith, E., *An Image Deblurring Method Using Diffraction Gratings*, 3692 OPTICS COMMUNICATIONS 101-106 (1981)
1080	Protective Order filed on March 5, 2019, *In the Matter of: Certain Dental and Orthodontic Scanners and Software*, ITC Inv. No. 337-TA-1144
1081	Order No. 8 Granting the Parties' Joint Motion to Enter Addendum to the Protective Order filed on April 24, 2019, *In the Matter of: Certain Dental and Orthodontic Scanners and Software*, ITC Inv. No. 337-TA-1144

APPENDIX B - ADDITIONAL REAL PARTIES-IN-INTEREST

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

I hereby certify that the word count for the foregoing Petition totals 13,421 words in the body of the petition and 571 words in the figures, excluding the parts which are exempted by 37 C.F.R. § 42.24(a)(1).

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CERTIFICATE OF FILING AND SERVICE

The undersigned hereby certifies that on this 9th day of December, 2019, a true and correct copy of the foregoing **PETITION FOR *INTER PARTES* REVIEW FOR U.S. PATENT NO. 8,102,538 PURSUANT TO 35 U.S.C. §§UNDER 35 U.S.C. §§ 311-319 and 37 C.F.R. § 42.100 *et seq.* and EXHIBITS 1001-1048, 1050, 1056-1057, 1059, 1064, and 1068-1081** are being filed via PTAB E2E and served by overnight UPS on the correspondence address of record for **U.S. Patent No. 8,102,538** as follows:

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