

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

MOTOROLA MOBILITY LLC,
Petitioner,

v.

LARGAN PRECISION CO., LTD.,
Patent Owner.

IPR2022-01210
Patent 9,969,519 B1

Before JON M. JURGOVAN, NORMAN H. BEAMER, and
NABEEL U. KHAN, *Administrative Patent Judges*.

JURGOVAN, *Administrative Patent Judge*.

DECISION
Granting Institution of *Inter Partes* Review
35 U.S.C. § 314

I. INTRODUCTION

A. *Background and Summary*

Motorola Mobility LLC (“Petitioner”) filed a Petition (Paper 2, “Pet.”) requesting an *inter partes* review of claims 1–27 (“the challenged claims”) of U.S. Patent No. 9,696,519 B1 (“the ’519 patent,” Ex. 1001). Largan Precision Co. Ltd. (“Patent Owner”) timely filed a Preliminary Response (Paper 6, “Prelim. Resp.”). With our authorization, Petitioner filed a Preliminary Reply (Paper 7, “Prelim. Reply”) and Patent Owner filed a Preliminary Sur-reply (Paper 8, “Prelim. Sur-reply”) addressing the issue of real parties-in-interest.

An *inter partes* review may not be instituted “unless . . . the information presented in the petition . . . shows that there is a reasonable likelihood that the petitioner would prevail with respect to at least 1 of the claims challenged in the petition.” 35 U.S.C. § 314(a) (2018). Having considered the arguments and evidence presented by Petitioner and Patent Owner, we determine that Petitioner has demonstrated a reasonable likelihood of prevailing on the challenged claims of the ’519 patent and we institute *inter partes* review as to the challenged claims of the ’519 patent on all the grounds of unpatentability set forth in the Petition.

B. *Related Proceedings*

The parties identify the following pending matters as involving the ’519 patent: *Largan Precision Co., Ltd. v. Motorola Mobility LLC*, Case No. 4:21-cv-09138 (N.D. Cal.). Pet. ix; Paper 3, 2.

C. *Real Parties-in-Interest*

Petitioner identifies itself as the sole real party-in-interest. Pet. ix. Patent Owner identifies itself as the sole real party-in-interest. Paper 3, 2.

D. The '519 Patent (Ex. 1001)

The '519 patent, titled “Imaging Optical Lens Assembly, Image Capturing Apparatus and Electronic Device,” relates to an imaging optical lens assembly having a total of five lens elements. Ex. 1001, code (54), code (57). As background, the '519 patent states that there is a trend in using “photographing modules” in various intelligent products, including mobile phones, tablet computers, optical recognition devices, rear view cameras, and other devices, and that there is an increasing demand for lens systems with high image quality and specifications. *Id.* at 1:19–30. The '519 patent further explains “there is a trend in the market towards miniaturized photographing modules featuring wide angles of view” that would be applicable to the mentioned devices. *Id.* at 1:31–36. The '519 patent further explains that conventional lens assemblies usually require lens elements of large size to capture an image of a larger area, but this increases total track length of the assembly and makes it difficult to reduce the device's size. *Id.* at 1:36–42. Viewed conversely, the strict size requirement of the lens module limits its field of view. *Id.* at 1:42–44.

To address this need, the '519 patent describes an imaging optical lens assembly with five lens elements having specific characteristics and properties. *Id.* at 1:66–2:10. Figure 1A of the '519 patent, reproduced below, illustrates one embodiment of the '519 patent's optical lens assembly.

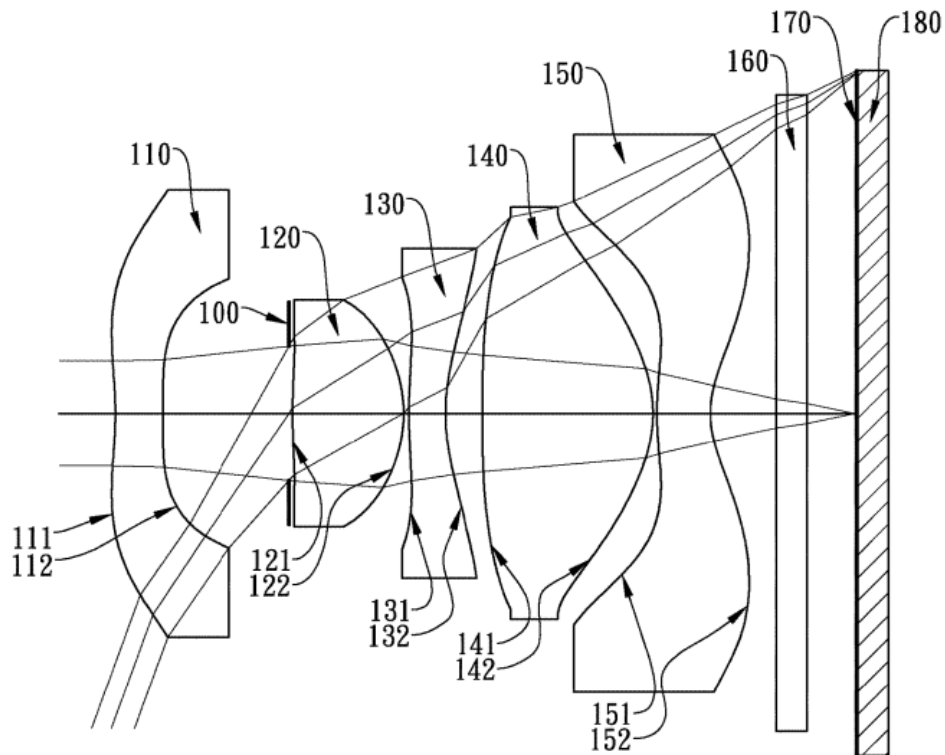


Fig. 1A

Figure 1A shows an image capturing apparatus. *Id.* at 8:27–29. The apparatus includes, from object side to image side, a first (110), second (120), third (130), fourth (140), and fifth (150) lens elements with object side and image side surfaces. *Id.* at 8:33–39. The apparatus further comprises a stop 100 and an image sensor 180 where image plane 170 is located. *Id.*

The first lens element 110 has negative refractive power and an object-side surface 111 that is concave in a paraxial region thereof, and an image-side surface 112 that is concave in a paraxial region thereof, which are both aspheric. *Id.* at 8:40–43. At least one convex shape is in an off-

axial region on the object-side surface 111. *Id.* at 8:43–46. The first lens element 111 is made of plastic material.

The second lens element 120 with positive refractive power with an object-side surface 121 that is convex in a paraxial region thereof and an image-side surface 122 that is convex in a paraxial region thereof, which are both aspheric. *Id.* at 8:47–50. The second lens element 120 is made of plastic material. *Id.* at 8:51.

The third lens element 130 has a negative refractive power and has an object-side surface 131 that is convex in a paraxial region thereof and an image-side surface 132 that is concave in a paraxial region thereof, which are both aspheric. *Id.* at 8:52–55. The third lens element 130 is made of plastic material. *Id.* at 8:55–56.

The fourth lens element 140 has a positive refractive power with an object-side surface 141 that is convex in a paraxial region thereof and an image-side surface 142 that is convex in a paraxial region. *Id.* at 8:57–60. The surfaces 141, 142 are both aspheric. *Id.* at 8:59. The fourth lens element 140 is made of plastic material. *Id.* at 8:60.

The fifth lens element 150 has a negative refractive power and has an object-side surface 151 that is convex in a paraxial region thereof and an image-side surface 152 that is concave in a paraxial region thereof. *Id.* at 8:61–64. Both surfaces 151 and 152 are aspheric, and the image-side surface 11 has at least one convex shape in an off-axial region. *Id.* at 8:64–66. The fifth lens element 150 is made of plastic material. *Id.* at 8:66–67.

The '519 patent also places certain conditions on the apparatus's elements. For example, claim 1 provides the following conditions:

$$|R4/R3| < 1.0;$$

$$f5/f3 < 1.0;$$

$$-10.0 < R1/f < 0$$

where R1 is a curvature radius of the object-side surface of the first lens element, R3 is a curvature radius of an object-side surface of the second lens element, R4 is a curvature radius of an image-side surface of the second lens element, f is a focal length of the imaging optical lens assembly, $f3$ is a focal length of the third lens element, $f5$ is a focal length of the fifth lens element.

The '519 patent includes another embodiment (claim 14) with the following conditions.

$$|R4/R3| < 2.0;$$

$$f1/f3 < 2.0;$$

$$0.15 < Yc11/Yc52 < 1.20$$

where $f1$ is a focal length of the first lens element, $Yc11$ is a vertical distance between an off-axial critical point on the object-side surface of the first lens element and an optical axis, $Yc52$ is a vertical distance between an off-axial critical point on the image-side surface of the fifth lens element and the optical axis.

The '519 patent includes a further embodiment (claim 23) with the following conditions:

$$|R4/R3| < 4.0;$$

$$f1/f3 < 5.0.$$

E. Illustrative Claim

Of the challenged claims only claims 1, 14, and 23 are independent. Claim 1 is representative and is reproduced below with limitation identifiers in brackets corresponding to claim analysis headings in the Petition. *See, e.g.,* Pet. 23–31.

[1.1] An imaging optical lens assembly, comprising, in order from an object side to an image side:

[1.2] a first lens element with negative refractive power having an object-side surface being concave in a paraxial region thereof;

[1.3] a second lens element having positive refractive power;

[1.4] a third lens element having negative refractive power;

[1.5] a fourth lens element having positive refractive power; and

[1.6] a fifth lens element with negative refractive power having an image-side surface being concave in a paraxial region thereof, and at least one convex shape in an off-axial region on the image-side surface;

[1.7] wherein the imaging optical lens assembly has a total of five lens elements;

[1.8] and wherein a curvature radius of the object-side surface of the first lens element is $R1$, a curvature radius of an object-side surface of the second lens element is $R3$, a curvature radius of an image-side surface of the second lens element is $R4$, a focal length of the imaging optical lens assembly is f , a focal length of the third lens element is $f3$, a focal length of the fifth lens element is $f5$, and the following conditions are satisfied:

$$|R4/R3| < 1.0;$$

$$f5/f3 < 1.0;$$

$$-10.0 < R1/f < 0.$$

Ex. 1001, 33:2–28.

F. Evidence

The Petition relies on the following references:

Reference	Exhibit No.
US 2015/0098137 A1; filed August 15, 2014; published April 9, 2015; (“Chung”).	1004
US 2013/0182339 A1; filed January 9, 2013; published July 18, 2013; (“Sekine”)	1005

Petitioner also relies on the Declaration of David Aikens (Ex. 1003) in support of its Petition. Patent Owner relies on the Declaration of Julie L. Bentley, Ph.D. (Ex. 2001) in support of its Preliminary Response. The parties rely on other exhibits as noted below.

G. Asserted Grounds of Unpatentability

Petitioner asserts that the challenged claims would have been unpatentable on the following grounds:

Claim(s) Challenged	35 U.S.C. § ¹	Reference(s)/Basis
1–18, 20–27	103	Chung (Embodiment 11), Sekine
1–7, 9–27	103	Chung (Embodiment 12), Sekine

Pet. 2.

¹ The Leahy-Smith America Invents Act (“AIA”), Pub. L. No. 112-29, 125 Stat. 284, 287–88 (2011), amended 35 U.S.C. §§ 102 and 103 and became effective March 16, 2013. Because the ’397 patent was filed before this date, the pre-AIA versions of 35 U.S.C. §§ 102 and 103 apply.

II. REAL PARTIES-IN-INTEREST

Patent Owner argues that Petitioner “purposefully omitted an RPI to gain an advantage in this forum.” Prelim. Resp. 9. More specifically, Patent Owner argues Petitioner failed to disclose Sunny Optical Technology Company Limited (“Sunny”), which Patent Owner identifies as Petitioner’s “supplier of the lens assemblies accused of infringement in the related litigation.” *Id.* at 9–10. According to Patent Owner, “if [Petitioner] ultimately loses in a final written decision” then “Sunny, as the supplier and the party that benefits most directly from cancelation of the Challenged Claims, will remain free to mount a second attack.” *Id.* at 10.

Notably, Petitioner argues that “Sunny is not time-barred” from filing a Petition challenging the ’519 patent and Patent Owner does not dispute this contention. Prelim. Reply 1. We thus find that for purposes of institution, we need not address whether Sunny is an unnamed real party-in-interest “because, even if it were, it would not create a time bar or estoppel under 35 U.S.C. § 315.” *SharkNinja Operating LLC v. iRobot Corp.*, IPR2020-00734, Paper 11 at 18 (PTAB Oct. 6, 2020) (precedential); *see also Intel Corp. v. Alacritech, Inc.*, IPR2017-01391, Paper 8 at 3–6 (PTAB Nov. 28, 2017) (holding that the Board will not address the argument for purposes of institution that a litigation co-defendant should be a named a real party-in-interest in the absence of an allegation that the co-defendant would be time barred under section 315(b)). We find that this “approach better serves the interest of cost and efficiency.” *SharkNinja*, Paper 11 at 20; 37 C.F.R. § 42.1(b).

Accordingly, we find that Patent Owner’s arguments concerning Sunny not being named as a real party-in-interest do not form a basis to deny institution under our circumstances.

III. ANALYSIS OF ASSERTED GROUNDS

A. *Principles of Law*

Petitioner bears the burden of persuasion to prove unpatentability of the claims challenged in the Petition, and that burden never shifts to Patent Owner. *Dynamic Drinkware, LLC v. Nat’l Graphics, Inc.*, 800 F.3d 1375, 1378 (Fed. Cir. 2015).

A patent claim is unpatentable under 35 U.S.C. § 103(a) if the differences between the claimed subject matter and the prior art are such that the subject matter, as a whole, would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. *KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 406 (2007). The question of obviousness is resolved on the basis of underlying factual determinations including: (1) the scope and content of the prior art; (2) any differences between the claimed subject matter and the prior art; (3) the level of skill in the art; and (4) any objective evidence of obviousness or non-obviousness.² *Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966).

B. *Level of Ordinary Skill in the Art*

In determining the level of ordinary skill in the art, various factors may be considered, including the “type of problems encountered in the art; prior art solutions to those problems; rapidity with which innovations are made; sophistication of the technology; and educational level of active

² Neither party has relied on objective evidence at this juncture of the proceeding.

workers in the field.” *In re GPAC Inc.*, 57 F.3d 1573, 1579 (Fed. Cir. 1995) (internal quotation marks and citation omitted).

Petitioner argues that a person of ordinary skill in the art (“POSITA”) “would include someone who had . . . (i) a Bachelor’s degree in Physics, Optical Sciences, or equivalent training, as well as (ii) approximately three years of experience in designing multi-lens optical systems.” Pet. 7–8. “Lack of work experience could have been offset by additional education, and vice versa.” *Id.* at 7. In addition, Petitioner argues that a POSITA would have had experience in analyzing, tolerancing, adjusting, and optimizing multi-lens systems for manufacturing, and would have been familiar with the specifications of lens systems and their fabrication. *Id.* According to Petitioner, a “POSITA would have understood the fundamentals of optical aberration theory, and understood and used standard techniques for making lenses cheaper and more effective, especially for lens systems used in mobile devices.” *Id.* In addition, Petitioner argues, “a POSITA would have known how to use lens design software such as Code V, Oslo, and ZEMAX, and would have taken a lens design course or had equivalent training.” *Id.* at 7–8. A POSITA would have regularly used such software to create new lens designs, including through optimizing pre-existing lens designs to reach a desired design.” *Id.* at 8. Petitioner argues a “POSITA would have followed and regularly consulted books, articles, and other publications by the Society of Photo-Optical Instrumentation Engineers (“SPIE”).” *Id.* (citing Ex. 1003 ¶¶ 33–37). “The knowledge and skill of a POSITA is reflected in numerous prior art textbooks and publications discussed herein.” *Id.* (citing Ex. 1003 ¶¶ 39–45).

Patent Owner’s declarant, Dr. Bentley, testifies that “a person of ordinary skill in the art around the time of the invention would have had a bachelor’s degree in physics or optics, and at least three years of experience in the field of optical design, or its equivalent experience.” Ex. 2001 ¶ 28.

For purposes of this Decision, we adopt Petitioner’s proposed level of ordinary skill. We note, however, that the two proposed levels of ordinary skill are nearly identical and our analysis and conclusions would not change under Patent Owner’s proposed level of ordinary skill.

C. Claim Construction

We apply the same claim construction standard used in district court actions under 35 U.S.C. § 282(b), namely that articulated in *Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005) (en banc). See 37 C.F.R. § 42.100(b) (2020).

In applying that standard, claim terms generally are given their ordinary and customary meaning as would have been understood by a person of ordinary skill in the art at the time of the invention and in the context of the entire patent disclosure. *Phillips*, 415 F.3d at 1312–13. “In determining the meaning of the disputed claim limitation, we look principally to the intrinsic evidence of record, examining the claim language itself, the written description, and the prosecution history, if in evidence.” *DePuy Spine, Inc. v. Medtronic Sofamor Danek, Inc.*, 469 F.3d 1005, 1014 (Fed. Cir. 2006) (citing *Phillips*, 415 F.3d at 1312–17). Only claim terms in controversy require express construction, “and only to the extent necessary to resolve the controversy.” *Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co.*, 868 F.3d 1013, 1017 (Fed. Cir. 2017); see also *Vivid Techs., Inc. v. Am. Sci. & Eng’g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999) (“[O]nly those terms need

be construed that are in controversy, and only to the extent necessary to resolve the controversy.”).

Petitioner does not propose a specific construction for any terms and instead argues that “no claim terms require specific construction to resolve the unpatentability issues presented” in their Petition. Pet. 12. Patent Owner also does not propose any specific constructions in their Preliminary Response, nor does their declarant, Dr. Bentley.

We determine that, at this stage of the proceeding, no explicit constructions are required to resolve the dispute between the parties. A final determination as to claim construction will be made at the close of the proceeding, after any hearing, based on all the evidence of record. The parties are expected to assert all their claim construction arguments and evidence in the Petition, Patent Owner’s Response, Petitioner’s Reply, Patent Owner’s Sur-reply, or otherwise during trial, as permitted by our rules.

D. Obviousness over Chung Embodiment 11 and Sekine

Petitioner argues claims 1–18 and 20–27 would have been obvious over Chung Embodiment 11 and Sekine. Pet. 13–71. Below we provide a brief overview of Chung Embodiment 11 and Sekine and then analyze Petitioner’s contentions in light of Patent Owner’s arguments.

1. Overview of Chung Embodiment 11

Chung is titled “Wide-Angle Image Taking Lens System,” and it discloses several embodiments of five-lens systems satisfying various conditions. Ex. 1004, codes (54), (57). Chung’s Embodiment 11 is depicted below in Figure 11A.

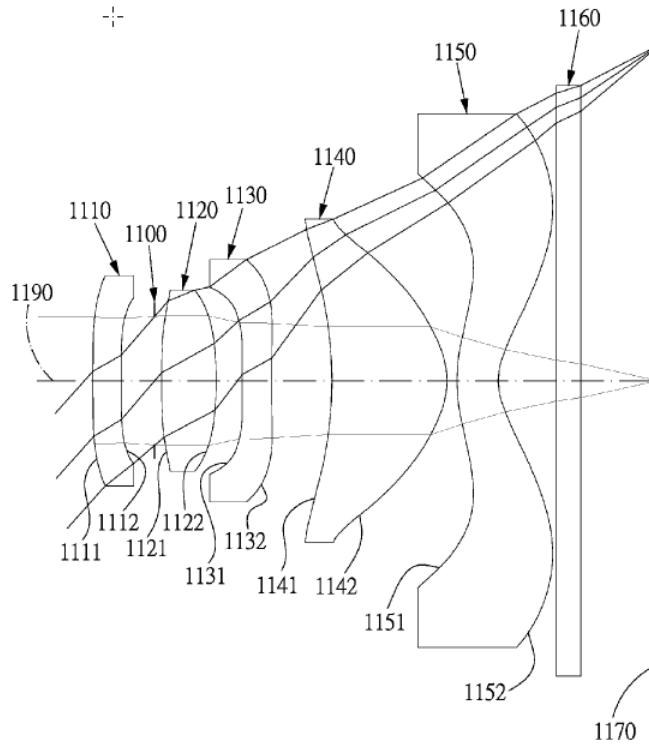


FIG.11A

Chung's Figure 11A shows, from object side to image side, first lens element 1110, second lens element 1120, third lens element 1130, fourth lens element 1140, fifth lens element 1150, an IR cut filter 1160, and an image plane 1170. *Id.* ¶ 179. Aperture stop 1100 is between the first and second lens elements. *Id.*

The first lens element 1110 with a negative refractive power has an object-side surface 1111 that is concave near the optical axis 1190 and an image-side surface 1112 that is convex near the optical axis 1190. *Id.* ¶ 180.

The second lens element 1120 with a positive refractive power has an object-side surface 1121 that is convex near optical axis 1190 and an image-side surface 1122 that is convex near the optical axis. *Id.* ¶ 181.

The third lens element 1130 with a negative refractive power has an object-side surface 1131 that is convex near the optical axis 1190 and an image-side surface 1132 that is concave near optical axis 1190. *Id.* ¶ 182.

The fourth lens element 1140 with a positive refractive power has an object-side surface 1141 that is concave near optical axis 1190 and an image-side surface 1142 that is convex near the optical axis 1190. *Id.* ¶ 183.

The fifth lens element 1150 has a negative refractive power and an object-side surface 1151 that is convex near the optical axis 1190 and an image-side surface 1152 that is concave near the optical axis 1190. The fifth lens element 1150 has more than one inflection point formed on the surfaces 1151, 1152. *Id.* ¶ 184.

The first through fifth lens elements are made of plastic material, and all surfaces of the lens elements are aspheric. *Id.* ¶¶ 180–184.

Further properties and characteristics of Chung's Embodiment 11 are shown below in Table 21:

TABLE 21

(Embodiment 11)							
f(focal length) = 2.574 mm, Fno = 2.4, HFOV = 47.97 deg.							
Surface		Curvature Radius	Thickness	Material	index	Abbe #	Focal length
0	Object	Plane	Infinity				
1	Lens 1	-39.1130(ASP)	0.24	Plastic	1.515	57.0	-133.92
2		-90.6338(ASP)	0.29				
3	Aperture stop	Plane	0.06				
4	Lens 2	7.6644(ASP)	0.47	Plastic	1.544	56.5	3.97
5		-2.9441(ASP)	0.22				
6	Lens 3	90.0000(ASP)	0.25	Plastic	1.650	21.4	-12.55
7		7.4734(ASP)	0.52				
8	Lens 4	-2.8942(ASP)	0.98	Plastic	1.533	55.7	1.39
9		-0.6603(ASP)	0.09				
10	Lens 5	1.3075(ASP)	0.35	Plastic	1.650	21.4	-1.62
11		0.5204(ASP)	0.49				
12	IR-filter	Plane	0.21	Glass	1.517	64.2	
13		Plane	0.66				
14	Image	Plane					

For example, Table 1 above shows values for curvature radii of the lens elements' surfaces, focal lengths for the lens elements and overall system, lens material, refractive index, Abbe number, and half field of view (HFOV) for the system. *Id.* ¶ 186.

2. Overview of Sekine

Sekine is titled “Image Pickup Lens” and describes a wide-angle pickup lens having small F-value, high resolution, and small distortion. Ex. 1005, codes (54), (57). The image pickup lens has, in order from object side to image side, a first lens having a positive refractive power with a concave surface facing the object side; an aperture stop; a second lens having a negative refractive power with a concave surface facing the image side; a third lens having a positive refractive power; a fourth lens having a positive refractive power with a concave surface facing the object side; and a

fifth lens having a negative refractive power with a concave surface facing the image side. *Id.* ¶ 9.

Sekine sets forth various conditions to be satisfied in the design of its wide-angle pickup lens. These conditions include $|R4/R3|$ and $R1/f$ criteria. *Id.* ¶¶ 11–14, 16–18, 49, 55, 61, 79, 85 (Tables 1, 2, 5, 6).

3. *Combination of Chung Embodiment 11 and Sekine*

Petitioner contends that a POSITA implementing Chung would have been motivated to incorporate Sekine’s teachings on maintaining image quality at wider fields of view. Pet. 15–22. Specifically, Petitioner notes that the references are analogous, and both are directed to wide-angle systems that provide high-quality images, have small five-lens assemblies with aspheric plastic lenses, for use in mobile devices. *Id.* at 15–16 (citing Ex. 1004 ¶¶ 3, 5, 8, 201; Ex. 1005 ¶¶ 3–8, 53, 91, 94).

Petitioner contends that both teach systems with a first lens having an object-side surface that is concave in the paraxial region. *Id.* at 16 (citing Ex. 1004 ¶¶ 180, 190). Chung explains that its first lens causes aberrations to be corrected with the second lens. *Id.* (citing Ex. 1004 ¶¶ 15, 32). According to Petitioner, Sekine explains how to correct aberrations with its second lens, and further teaches reducing aberrations by balancing the concavity of the first lens against the system focal length, i.e., $r1/f$. *Id.* (citing Ex. 1005 ¶¶ 13, 18). Petitioner contends that Chung and Sekine complement each other. *Id.* (citing Ex. 1003 ¶¶ 104–105).

Petitioner contends that Chung and other references recognize the need for high image quality at wide angles (i.e., higher FOV). *Id.* (citing Ex. 1004 ¶¶ 3, 5, 7; Ex. 1019, 20; Ex. 1007 ¶¶ 55, 63; Ex. 1003 ¶ 106). Chung identifies the popularity of self-portraits or “selfies” as a reason for

increased demand. *Id.* (citing Ex. 1004 ¶ 5). Petitioner contends that “[o]ther background prior art publications reflect the known benefits of lenses with wider angles—including for cell-phone selfies and video chat applications—thus confirming that a POSITA would have been motivated to implement the Chung designs at the higher end of the disclosed FOV, i.e., FOV=115 degrees.” *Id.* at 17 (citing Ex. 1008, 5–6 (noting that wider angles lenses “capture more people and background than a regular narrow angle module” and that “benefits include additional background information,” then providing examples of selfie and video as areas where wide angle lenses provide these benefits); Ex. 1003 ¶ 106).

Petitioner contends that Chung gives a preferred FOV of “ $86^{\circ} < \text{FOV} < 115^{\circ}$.” Pet. 17 (citing Ex. 1004 ¶¶ 20, 33; Ex. 1003 ¶ 106). Petitioner argues that, given the demands for camera systems with a higher FOV, a POSITA would have been motivated to push Chung’s embodiments to its higher end FOV of 115 degrees, and would have sought out teachings on maintaining image quality while increasing FOV. *Id.*

Petitioner contends that “[i]n doing so, a POSITA would have naturally encountered Sekine, which teaches improving image quality at wide viewing angles.” *Id.* (citing Ex. 1005 ¶¶ 3–8, 13–14, 49; Ex. 1003 ¶ 107). Petitioner argues that Sekine reinforces the importance of wider angles, and explains how to reduce aberrations in wide-angle systems using the ration “ $r1/f$ ” which is the ratio of curvature of the “curvature radius of the object side surface of first lens” to the “focal length of overall optical system.” *Id.* (citing Ex. 1005 ¶¶ 6–13, 49). Petitioner contends that a POSITA would have been motivated to apply Sekine’s teachings on $r1/f$ to

Chung Embodiment 11, in order to reduce aberrations. *Id.* at 17–18 (citing Ex. 1003 ¶ 107).

Petitioner argues that “Sekine discloses that $r1/f$ within $-70.0 < r1/f < 0$ allows for a wide angle while maintaining image quality.” *Id.* at 18 (citing Ex. 1005 ¶¶ 11–13). Petitioner contends that Sekine gives an upper limit of zero because otherwise “the object side of the first lens becomes a convex surface, so that it is disadvantageous in widening of the angle.” *Id.* Petitioner asserts that “Sekine correlates a lower (i.e., more negative) $r1/f$ with a wider angle—but warns that going too negative causes aberrations.” *Id.* (citing Ex. 1005 ¶ 13 (“if the $[r1/f]$ value is below the lower limit $[-70.0]$, it is advantageous in widening of the angle, however, the chromatic aberration at high image height deteriorates”); Ex. 1003 ¶ 108). Petitioner contends “a POSITA would have thus understood that Sekine describes a tradeoff with $r1/f$: a value closer to -70.0 widens the angle but undesirably affects aberrations, compared to an $r1/f$ closer to zero.” *Id.* Petitioner contends a POSITA would know that a very small $r1/f$ of -0.1 or -0.2 would result in a first lens that was too fast to be used with a wide field. *Id.* (citing Ex. 1003 ¶ 108; Ex. 1010, 402). Petitioner states that Sekine explains that an upper limit of -3.0 such that $-70 < r1/f < -3.0$ would permit shortening the total track length of the system. *Id.* (citing Ex. 1005 ¶ 15). Petitioner contends a POSITA would have been motivated to start with an $r1/f$ at or near -3.0 , and then reduce that value if possible to balance between aberration correction with shorter track length. *Id.* at 18–19 (citing Ex. 1003 ¶ 108).

Petitioner contends that a “POSITA would have appreciated that two simple design techniques were available for reaching $r1/f$ near -3.0 : (1) set

the radius of curvature to a smaller value; or (2) bend the lens so its r_1 nears $-3*f$. *Id.* at 19 (citing Ex. 1010, 50 (“useful to first vary only the curvatures”), 47 (“Bend an element. Change its shape but maintain its power.”), 607 (bending definition); Ex. 1019, 1 (“The lens parameters available to the designer for change . . . include the radii of curvature of the surfaces.”), 21, 80 (“One of the most powerful tools available to the lens designer is bending” (emphasis omitted)), 182; Ex. 1003 ¶ 109).

Petitioner contends “a POSITA would also be mindful of the need to minimize the power of the first lens while obtaining the wider field. *Id.* (citing Ex. 1003 ¶ 110). According to Petitioner, Smith explains that, in a wide-angle retrofocus system with a negative first lens and positive second lens, increasing the spacing between the negative and positive lenses improves performance by decreasing the required power of especially the front negative lens. *Id.* (citing Ex. 1010, 397 (“a large airspace will reduce the power of the components, especially of the front component”); Ex. 1003 ¶ 110). Petitioner contends that “increasing the field of view requires both decreasing the magnitude of r_1 while balancing this by increasing the spacing between lenses 1 and 2.” *Id.* Petitioner further argues that a “POSITA would implement an r_1/f ratio of -3 (as taught by Sekine), increase the spacing between lenses 1 and 2, and then reoptimize the lens with a wider field of view.” *Id.* Petitioner argues, in order to recover the lost track length, the POSITA would perform routine optimizations to reduce the other lens spacings as needed to maintain total track length. *Id.* at 19–20. Petitioner then contends that a “POSITA would then turn to the lens design program to find the balance between these competing objectives—a short TTL, a wide field of view, and improved image quality—and optimize r_1/f

to an appropriate value.” *Id.* at 20. In doing so, Petitioner contends that “a POSITA would have had a reasonable expectation of success in achieving an FOV of roughly 115 degrees for wide viewing angle, with an $r1/f$ near -3 or below for reduced aberrations and better performance.” *Id.* Petitioner contends that ZEMAX modeling confirms that “a POSITA would have had a reasonable expectation of success and required no undue experimentation in applying Sekine’s teachings to optimize Chung Embodiment 11.” *Id.* (citing Ex. 1003 ¶ 111).

We determine that Petitioner has shown sufficiently for purposes of institution that a POSITA would have combined Chung Embodiment 11 (or 12) with Sekine. Petitioner’s declarant, Mr. Aikens, who has extensive experience in optical design and engineering, explains that Chung Embodiment 11 and Sekine are both wide-angle systems that provide high-quality images, have five-lens assemblies with aspheric plastic lenses, and are “small size” for use with mobile devices. *Id.* at 15–16. We find it credible that a POSITA would consider the references together due to their similarities.

Furthermore, Chung explains that the first lens causes aberrations that can be corrected by the second lens, and Sekine teaches how to correct aberrations in the second lens by balancing concavity of the first lens against the system focal length, i.e., $r1/f$, and thus the references complement each other. *Id.* Mr. Aikens and Smith provide evidence that POSITA would have been motivated to start with an $r1/f$ at or near -3.0 to keep the total track length small, and then reduce that value to balance between aberration correction and short track length, by setting $r1$ smaller and by bending the lens near $-3*f$. Ex. 1003 ¶ 108; Ex. 1010, 47, 50, 607. Smith explained the

importance of minimizing power of the first lens while obtaining a wider field by increasing the distance between the first and second lenses, and then reoptimizing the lens with a wider field of view, and shortening other lens spacings to maintain a short total track length. Ex. 1010, 397; Ex. 1003

¶ 110. In other words, a POSITA would use a lens design program to balance between competing objectives—a short TTL, a wide field of view, and improved image quality—by optimizing r_1/f to an appropriate value. Pet. 20.

Patent Owner argues that combining the Chung Embodiment 11 or 12 with Sekine would result in an optical system with worse image quality or FOV than the starting designs. Prelim. Resp. 21–22 (citing Ex. 2001 ¶ 49), 39–40. But Petitioner explains that the objective is to balance a short TTL, a wide FOV, and improved image quality. Patent Owner does not explain why a POSITA would not accept sacrifices in resolution and image quality, for example, to achieve a shorter TTL or wider FOV. Thus, the record does not establish that a POSITA would not have combined Chung Embodiment 11 or 12 with Sekine to arrive at the claims of the '519 patent.

In addition, Patent Owner's calculations of f-number, image quality, resolution, CRA, incidence angles, and other parameters are based on Patent Owner's estimates from Petitioner's drawings, which may or may not be accurate. For example, Patent Owner argues that assumes that the entrance pupil diameter (EPD) of the system of Chung Embodiments 11 or 12 and Sekine is 0.50 mm. *Id.* at 23–24. Patent Owner also argues Chung Embodiment 11 and 12 with Sekine produce various CRA and incidence angles from Patent Owner's measurements of Petitioner's Figures. *Id.* at

30–38. We cannot conclude at this time that such rough estimates undermine Petitioner’s showing in such precise optical systems.

Patent Owner further argues that Chung Embodiment 11 and 12 are totally different optical systems having opposite arrangements of positive and negative power compared to Sekine. *Id.* at 40–42. While this may be so, this does not necessarily negate Chung’s and Sekine’s teachings to use the second lens to correct aberrations in the first lens. Ex. 1004 ¶¶ 15, 32; Ex. 1005 ¶¶ 13, 18; Ex. 1003 ¶¶ 104–105.

Patent Owner argues that Sekine’s teachings for widening FOV do not apply to Chung Embodiment 11 or 12. Prelim. Resp. 42–44. However, Petitioner relies on Sekine and Smith for teaching to use an FOV near -3.0 to permit shortening of the total track length. Pet. 18. Petitioner also relies on Smith’s teaching of setting the radius curvature to a smaller value and bending the lens so its r_1 nears $-3*f$. *Id.* at 19.

Patent Owner argues that in a petition filed in IPR2022-01170, Petitioner contended that a negative lens element tends to increase the field of view, and thus, Petitioner teaches against using a first lens with positive refractive power. Prelim. Resp. 44–45. Patent Owner argues that a POSITA would not have been motivated to modify Chung Embodiment 11 or 12 with Sekine to increase Chung’s FOV since Sekine has a positive first lens deemed unfavorable by Petitioner for increasing the FOV. *Id.* at 45. However, Petitioner’s proposed modification was not to replace the negative first lens of Chung’s Embodiment 11 or 12 with a positive one.

Patent Owner further argues that Sekine teaches that r_1/f should be within $-70.0 < r_1/f < 0$ for a wider angle, and that the more negative this value, the wider the angle. *Id.* at 46–47. Patent Owner argues that Petitioner works

against Sekine's teaching by adopting an $r1/f$ of -2.55 which is a much less negative number. *Id.* But Petitioner explained the reason for this was to balance having a short TTL as well as a wide angle. Pet. 18–19.

Thus, on the record developed thus far, Petitioner has shown sufficiently that a POSITA would have had reason to combine Chung Embodiment 11 (and Chung Embodiment 12) with a reasonable expectation of success in arriving at the '519 patent's claims.

4. *Claim 1*

Preamble [1.1] recites “An imaging optical lens assembly, comprising, in order from an object side to an image side.” Ex. 1001, 33:2–3. Petitioner contends that, to the extent the preamble is limiting, Chung Embodiment 11 discloses an optical lens assembly with lenses arranged from object-side to image-side. Pet. 23 (citing Ex. 1004 ¶ 55, Fig. 11A; Ex. 1003 ¶ 114).

Limitation [1.2] recites “a first lens element with negative refractive power having an object-side surface being concave in a paraxial region thereof.” Ex. 1001, 33:4–6. Petitioner contends that Chung Embodiment 11 has a “first lens element 1110 with a negative refractive power [having] an object-side surface 1111 being concave near an optical axis.” Pet. 23–24 (citing Ex. 1004 ¶ 180, Table 1; Ex. 1003 ¶¶ 115–116) (emphasis omitted, alteration in original).

Limitation [1.3] recites “a second lens element having positive refractive power.” Ex. 1001, 34:42. Petitioner contends that Chung Embodiment 11 has a “second lens element 1120 with a positive refractive power.” Pet. 25 (citing Ex. 1004 ¶ 181, Table 21; Ex. 1003 ¶¶ 118–112).

Limitation [1.4] recites “a third lens element having negative refractive power.” Ex. 1001, 33:8. Petitioner contends that Chung Embodiment 11 has a “third lens element 1130 with a negative refractive power.” Pet. 25 (citing Ex. 1004 ¶ 182, Table 21; Ex. 1003 ¶ 118–112).

Limitation [1.5] recites “a fourth lens element having positive refractive power.” Ex. 1001, 33:9–10. Petitioner contends that Chung Embodiment 11 discloses a “fourth lens element 1140 with a positive refractive power.” Pet. 25 (citing Ex. 1004 ¶ 183, Table 21; Ex. 1003 ¶¶ 118–112).

Limitation [1.6] recites “a fifth lens element with negative refractive power having an image-side surface being concave in a paraxial region thereof, and at least one convex shape in an off-axial region on the image-side surface.” Ex. 1001, 33:10–13. Petitioner contends that Chung Embodiment 11 discloses a fifth lens element 1150 with a negative refractive power [with] an image-side surface 1152 being concave near the optical axis.” Pet. 26 (citing Ex. 1004 ¶ 184, Table 21; Ex. 1003 ¶¶ 124–126). Petitioner contends that Chung’s Table 21 discloses Lens 5 with negative focal length (negative refractive power), and Surface 11 with positive curvature radius (paraxial concave image-side). *Id.* Petitioner contends that Lens 5 has off-axial convex shapes on its image-side because “more than one inflection point is formed on . . . the image-side surface 1152 of the fifth lens element 1150.” *Id.* at 27 (citing Ex. 1004 ¶ 184; Ex. 1003 ¶ 125) (emphasis omitted, alteration in original). Petitioner further contends that Chung’s Figure 11A shows Lens 5’s image-side with a paraxial concave shape and off-axial convex shapes. *Id.* (citing Ex. 1004, Fig. 11A; Ex. 1003 ¶¶ 127–129).

Limitation [1.7] recites “wherein the imaging optical lens assembly has a total of five lens elements.” Ex. 1001, 33:14–15. Petitioner contends that Chung Figure 11A shows an imaging optical lens assembly with five lens elements. Pet. 29 (citing Ex. 1004, code (57); Ex. 1003 ¶ 131).

Limitation [1.8] recites “wherein a curvature radius of the object-side surface of the first lens element is $R1$, a curvature radius of an object-side surface of the second lens element is $R3$, a curvature radius of an image-side surface of the second lens element is $R4$, a focal length of the imaging optical lens assembly is f , a focal length of the third lens element is $f3$, a focal length of the fifth lens element is $f5$, and the following conditions are satisfied: $|R4/R3| < 1.0$; $f5/f3 < 1.0$; $-10.0 < R1/f < 0$.” Petitioner contends that Chung Embodiment 11 has $|R4/R3|$ of 0.3841, and $f5/f3$ of 0.129, satisfying $|R4/R3| < 1.0$ and $f5/f3 < 1.0$. Pet. 30 (citing Ex. 1004, Table 21; Ex. 1003 ¶¶ 132–133). Ex. 1001, 33:16–28.

Petitioner contends that although Chung discloses values that result in an $R1/f$ of -15.195, it would have been obvious for a POSITA to implement Chung Embodiment 11 with an $R1/f$ within the claimed range based on Sekine. *Id.* at 29–30. According to Petitioner, the optimized Chung Embodiment 11 satisfies all recited conditions. Petitioner contends ZEMAX modeling reached a design of $R1/f$ of -3.37; $|R4/R3|$ of 0.51; $f5/f3$ of 0.12. *Id.* at 31 (citing Ex. 1003 ¶ 135). Petitioner contends Sekine’s Embodiments 1, 2, 5, and 6 all satisfy the claimed ranges. *Id.* (citing Ex. 1005, Tables 1, 2, 5, 6; Ex. 1003 ¶ 136).

Patent Owner does not contest that the combination of Chung Embodiment 11 and Sekine discloses the preamble and limitations of claim 1. *See* Prelim. Resp.

Petitioner has shown a reasonable likelihood that a POSITA would have combined Chung Embodiment 11 and Sekine with a reasonable expectation of success, and that the preamble³ and limitations of claim 1 are disclosed by the combination. Accordingly, Petitioner has established a reasonable likelihood to prevail in showing claim 1 unpatentable as obvious over the combination of Chung Embodiment 11 and Sekine.

5. *Claim 14*

Preamble [14.1] of claim 14 recites “An imaging optical lens assembly, comprising, in order from an object side to an image side.” Ex. 1001, 34:36–37. Petitioner contends that this is disclosed by the combination of Chung Embodiment 11 and Sekine. *See* § III.D.4.

Limitation [14.2] recites “a first lens element with negative refractive power having an object-side surface being concave in a paraxial region thereof, and at least one convex shape in an off-axial region on the object-side surface.” Ex. 1001, 34:38–41. Petitioner contends that Chung Embodiment 11 has a “first lens element 1110 with a negative refractive power [having] an object-side surface 1111 being concave near an optical axis.” Pet. 53 (citing Ex. 1004 ¶ 180) (emphasis omitted, alteration in original). Petitioner contends Chung’s Figure 11A shows Lens 1’s image-side with off-axial convex shapes. *Id.* (citing Ex. 1004, Tables 21–22; Ex. 1003 ¶¶ 183–186).

Limitation [14.3] recites “a second lens element having positive refractive power.” Ex. 1001, 34:42. Limitation [14.4] recites “a third lens

³ Because we determine that the preamble is disclosed by the combination of Chung Embodiment 11 and Sekine, we need not decide whether the preamble is limiting.

element.” Ex. 1001, 34:43. Limitation [14.5] recites “a fourth lens element having positive refractive power.” Ex. 1001, 34:44–45. Limitation [14.6] recites “a fifth lens element with negative refractive power having an image-side surface being concave in a paraxial region thereof, and at least one convex shape in an off-axial region on the image-side surface.” Ex. 1001, 34:46–49. Limitation [14.7] recites “wherein the imaging optical lens assembly has a total of five lens elements.” Ex. 1001, 34:49–50. Petitioner contends that limitations [14.3] to [14.7] are disclosed by Chung Embodiment 11 and Sekine as explained for claim 1. Pet. 56 (citing Sect. IX.D.1 (Limitations [1.3]–[1.7])). *See* § III.D.4, *supra*.

Limitation [14.8] recites “wherein a curvature radius of an object-side surface of the second lens element is $R3$, a curvature radius of an image-side surface of the second lens element is $R4$, a focal length of the first lens element is $f1$, a focal length of the third lens element is $f3$, a vertical distance between an off-axial critical point on the object-side surface of the first lens element and an optical axis is $Yc11$, a vertical distance between an off-axial critical point on the image-side surface of the fifth lens element and the optical axis is $Yc52$, and the following conditions are satisfied: $|R4/R3| < 2.0$; $f1/f3 < 2.0$; $0.15 < Yc11/Yc52 < 1.20$.” Ex. 1001, 34:49–65. Petitioner contends that the obvious optimized implementation of Chung Embodiment 11 satisfies $|R4/R3| < 2.0$ as explained for limitation [1.8]. Pet. 57 (citing Sect. IX.D.1 (Limitation [1.8])); *see* § III.D.4. Petitioner further contends that a POSITA would have understood that obvious implementation—with a low magnitude $R1/f$ as taught by Sekine—to have $f1/f3 < 2.0$ and $0.15 < Yc11/Yc52 < 1.20$. *Id.* (citing Ex. 1003 ¶¶ 188–190). Petitioner contends that ZEMAX modeling confirms $|R4/R3| = 0.51$, $f1/f3 = 0.56$, and

$Yc11/Yc52 = 0.28$, all within the recited ranges. *Id.* at 57–58 (citing Ex. 1004, Table 22; Ex. 1003 ¶¶ 191–192).

Patent Owner argues that Chung Embodiment 11 has $f1/f3$ and $Yc11/Yc52$ values outside of the claimed ranges. Prelim. Resp. 47–52. Patent Owner also contends that Sekine’s values for $f1/f3$ are also outside the claimed range. *Id.* at 48. Patent Owner further argues that none of Sekine’s embodiments have a critical point $Yc11$ on the object-side of the first lens. *Id.* at 51. Patent Owner further contends that Petitioner’s modeling is not proper because it was generated by Petitioner in 2022. *Id.* at 52.

Petitioner shows that Sekine’s Embodiments 1, 2, 5, 6 have $f1/f3$ are within the claimed range. Pet. 66. In addition, Petitioner contends that it would have been obvious to optimize values selected from Chung Embodiment 11 and Sekine using modeling to arrive at the claimed invention. *Id.* at 57–58. Patent Owner does not sufficiently refute Petitioner’s contentions to undermine its showing for claim 14.

Petitioner has shown a reasonable likelihood that a POSITA would have combined Chung Embodiment 11 and Sekine with a reasonable expectation of success, and that the preamble and limitations of claim 14 are disclosed by the combination. Accordingly, Petitioner has established a reasonable likelihood to prevail in showing claim 14 unpatentable as obvious over the combination of Chung Embodiment 11 and Sekine.

6. *Claim 23*

Preamble [23.1] recites “An imaging optical lens assembly, comprising, in order from an object side to an image side.” Ex. 1001, 35:38–39. Limitation [23.2] recites “a first lens element with negative refractive power having an object-side surface being concave in a paraxial

region thereof, and at least one convex shape in an off-axial region on the object-side surface.” Ex. 1001, 35:40–43. Limitation [23.3] recites “a second lens element having positive refractive power.” Ex. 1001, 35:44. Limitation [23.4] recites a “third lens element.” Ex. 1001, 35:45. Petitioner contends that Chung Embodiment 11 discloses limitations [23.1] to [23.4] for the reasons stated for limitations [1.1] to [1.4] and [14.1] to [14.4]. Pet. 63–64 (citing Ex. 1003 ¶¶ 206–209).

Limitation [23.5] recites “a fourth lens element with positive refractive power having an image-side surface being convex in a paraxial region thereof.” Ex. 1001, 35:46–48. Petitioner contends that Chung discloses Lens 4 with a positive focal length (positive refractive power), and Surface 9 with a negative curvature radius (paraxial convex image-side). Pet. 64–65 (citing Ex. 1004, Table 21; Ex. 1003 ¶ 210). Petitioner contends the fourth lens maintains these characteristics post-optimization. *Id.* at 65 (citing Ex. 1003 ¶ 211).

Limitation [23.6] recites “a fifth lens element with negative refractive power having an image-side surface being concave in a paraxial region thereof, and at least one convex shape in an off-axial region on the image-side surface.” Ex. 1001, 35:49–36:2. Limitation [23.7] recites “wherein the imaging optical lens assembly has a total of five lens elements and further comprises an aperture stop disposed between the first lens element and the second lens element.” Ex. 1001, 36:3–6.

Petitioner contends that Chung Embodiment 11 discloses these limitations. Pet. 65 (citing Sect. IX.D.1 (Limitations [1.6]–[1.7]); Sect. IX.D4 (Limitation [4.1])). Petitioner contends these lenses retain all characteristics post optimization. *Id.* (citing Ex. 1003 ¶¶ 212–214).

Limitation [23.8] recites “wherein a curvature radius of an object-side surface of the second lens element is $R3$, a curvature radius of the image-side surface of the second lens element is $R4$, a focal length of the first lens element is $f1$, a focal length of the third lens element is $f3$, and the following conditions are satisfied: $|R4/R3| < 4.0$; $f1/f3 < 5.0$.” Ex. 1001, 36:7–15.

Petitioner contends that Chung Embodiment 11 has $|R4/R3|$ of 0.3841, satisfying $|R4/R3| < 4.0$. See Pet. 66 (citing Sect. IX.D.1 (Limitation [1.8])). Petitioner contends that incorporating $R1/f$ near -3.0 results in $f1/f3 = 0.56$. *Id.* (citing Sect. IX.D.14 (Limitation [14.7], IX.C (Table 1)); Ex. 1003 ¶¶ 215–216).

Petitioner contends that the obviousness of these requirements is further confirmed by Chung Embodiment 1 which simultaneously satisfies $|R4/R3| < 4.0$; $f1/f3 < 5.0$. *Id.* (citing Ex. 1004, Table 1 ($|R4/R3|$ of 0.42 and $f1/f3$ of 1.99); Ex. 1003 ¶ 217. Petitioner also contends that Sekine Embodiments 1, 2, 5, and 6 simultaneously satisfy $|R4/R3| < 4.0$; $f1/f3 < 1.0$. *Id.* (citing Ex. 1003 ¶¶ 217–218).

Patent Owner argues that Chung Embodiment 11 fails to disclose $f1/f3 < 5.0$. Prelim. Resp. 53. However, Petitioner noted that it incorporated $R1/f$ near -3.0 which resulted in $f1/f3 = 0.56$, which is within the claimed range. Pet. 66. Thus, Patent Owner’s argument does not undermine Petitioner’s showing.

Petitioner has shown a reasonable likelihood that a POSITA would have combined Chung Embodiment 11 and Sekine with a reasonable expectation of success, and that the preamble and limitations of claim 23 are disclosed by the combination. Accordingly, Petitioner has established a

reasonable likelihood to prevail in showing claim 23 unpatentable as obvious over the combination of Chung Embodiment 11 and Sekine.

7. *Remaining Dependent Claims*

Petitioner contends claims 2–13, 15–22, and 24–27 would have been obvious in light of the combination of Chung Embodiment 11 and Sekine and provides evidence and reasoning supporting its contentions. Pet. 31–52, 59–63, 66–71. Patent Owner does not separately dispute Petitioner’s contentions for these claims. We determine Petitioner has presented sufficient evidence to establish that the combination of Chung Embodiment 11 and Sekine teaches the limitations of the remaining challenged claims.

E. *Obviousness over Chung Embodiment 12 and Sekine*

Petitioner argues that claims 1–7 and 9–27 would have been obvious over Chung Embodiment 12 and Sekine. Pet. 71–125. Below we provide a brief overview of Chung Embodiment 12 and then analyze Petitioner’s contentions in light of Patent Owner’s arguments.

1. *Chung Embodiment 12*

Chung’s Embodiment 12 is depicted below in Figure 12A.

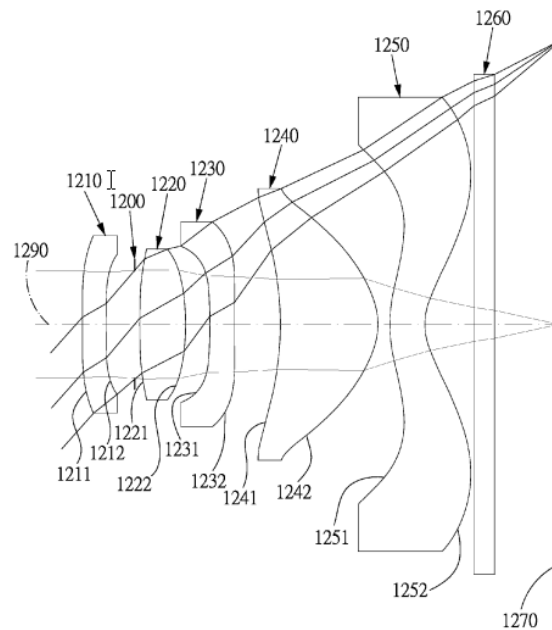


FIG.12A

Chung's Figure 12A shows, from object side to image side, first lens element 1210, second lens element 1220, third lens element 1230, fourth lens element 1240, fifth lens element 1250, an IR cut filter 1260, and an image plane 1270. Ex. 1004 ¶ 189. Aperture stop 1200 is between the first and second lens elements. *Id.*

The first lens element 1210 with a negative refractive power has an object-side surface 1211 that is concave near the optical axis 1290 and an image-side surface 1212 that is convex near the optical axis 1290. *Id.* ¶ 190.

The second lens element 1220 with a positive refractive power has an object-side surface 1221 that is convex near optical axis 1290 and an image-side surface 1222 that is convex near the optical axis. *Id.* ¶ 191.

The third lens element 1230 with a negative refractive power has an object-side surface 1231 that is concave near the optical axis 1290 and an image-side surface 1232 that is concave near optical axis 1190. *Id.* ¶ 192.

The fourth lens element 1240 with a positive refractive power has an object-side surface 1241 that is concave near optical axis 1290 and an image-side surface 1242 that is convex near the optical axis 1290. *Id.* ¶ 193.

The fifth lens element 1250 has a negative refractive power and an object-side surface 1251 that is convex near the optical axis 1290 and an image-side surface 1252 that is concave near the optical axis 1290. *Id.* ¶ 194. The fifth lens element 1250 has more than one inflection point formed on the surfaces 1251, 1252. *Id.*

The first through fifth lens elements are made of plastic material, and all surfaces of the lens elements are aspheric. *Id.* ¶¶ 190–194.

Further properties and characteristics of Chung's Embodiment 12 are shown below in Table 23:

TABLE 23

(Embodiment 12)							
f(focal length) = 2.555 mm, Fno = 2.4, HFOV = 48.18 deg.							
Surface		Curvature Radius	Thickness	Material	index	Abbe #	Focal length
0	Object	Plane	Infinity				
1	Lens 1	−65.5134(ASP)	0.24	Plastic	1.515	57.0	−491.75
2		−88.5093(ASP)	0.29				
3	Aperture stop	Plane	0.05				
4	Lens 2	8.9984(ASP)	0.46	Plastic	1.544	56.5	3.68
5		−2.5262(ASP)	0.25				
6	Lens 3	−9.6224(ASP)	0.25	Plastic	1.650	21.4	−8.94
7		14.8291(ASP)	0.46				
8	Lens 4	−2.7750(ASP)	0.99	Plastic	1.533	55.7	1.46
9		−0.6818(ASP)	0.12				
10	Lens 5	1.3228(ASP)	0.35	Plastic	1.650	21.4	−1.76
11		0.5481(ASP)	0.50				
12	IR-filter	Plane	0.21	Glass	1.517	64.2	
13		Plane	0.65				
14	Image	Plane					

For example, Table 23 above shows values for curvature radii of the lens elements' surfaces, focal lengths for the lens elements and overall system, lens material, refractive index, Abbe number, and half field of view (HFOV) for the system. *Id.* ¶ 196.

2. *Combination of Chung Embodiment 12 and Sekine*

Petitioner contends that a POSITA would have combined Chung Embodiment 12 and Sekine for the same reasons already discussed in Section III.D.3. Pet. 15–22. For the reasons explained, for purposes of institution, Petitioner has established a reasonable likelihood that a POSITA would have combined Chung Embodiment 12 and Sekine notwithstanding Patent Owner's arguments to the contrary. Prelim. Resp. 21–47.

3. *Claim 1*

The preamble [1.1] of claim 1 recites “An imaging optical lens assembly, comprising, in order from an object side to an image side.” To the extent the preamble is limiting, Petitioner contends that Chung Embodiment 12 is an optical lens assembly with lenses arranged from object-side to image-side. Pet. 75–76 (citing Ex. 1004 ¶ 55, Fig. 12A; Ex. 1003 ¶ 235).

Limitation [1.2] recites “a first lens element with negative refractive power having an object-side surface being concave in a paraxial region thereof.” Petitioner contends that Chung Embodiment 12 has a “first lens element 1210 with a negative refractive power [having] an object-side surface 1211 being concave near an optical axis.” Pet. 76–77 (citing Ex. 1004 ¶ 190) (emphasis omitted, alteration in original). Petitioner contends that Chung's Table 23 confirms this, disclosing Lens 1 with negative focal length (negative refractive power), and Surface 1 with negative curvature radius (paraxial concave object-side surface). *Id.* at

76–77 (citing Ex. 1004, Table 23; Ex. 1003 ¶¶ 236–237). Petitioner contends the first lens maintains these characteristics post-optimization. *Id.* at 77 (citing Ex. 1003 ¶ 238).

Limitation [1.3] recites “a second lens element having positive refractive power.” Limitation [1.4] recites “a third lens element having negative refractive power.” Limitation [1.5] recites “a fourth lens element having positive refractive power.” Petitioner contends that Chung Embodiment 12 has a “second lens element 1220 with a positive refractive power” (Ex. 1003 ¶ 191); a “third lens element 1230 with a negative refractive power” (Ex. 1003 ¶ 192); and a “fourth lens element 1240 with a positive refractive power.” (Ex. 1003 ¶ 193). Pet. 77–78. Petitioner contends that Chung’s Table 23 confirms, disclosing positive focal lengths for Lenses 2 and 4 (positive refractive power), and negative focal length for Lens 3 (negative refractive power). *Id.* at 78 (citing Ex. 1003 ¶ 239, Table 23). Petitioner contends the second, third, and fourth lenses maintain these characteristics post-optimization. *Id.* (citing Ex. 1003 ¶ 240).

Limitation [1.6] recites “a fifth lens element with negative refractive power having an image-side surface being concave in a paraxial region thereof, and at least one convex shape in an off-axial region on the image-side surface.” Petitioner contends that Chung Embodiment 12 has a “fifth lens element 1250 with a negative refractive power [having] an image-side surface 1152 being concave near the optical axis.” Pet. 79 (citing Ex. 1004 ¶ 194) (emphasis omitted, alteration in original). Petitioner contends that Chung’s Table 23 confirms, disclosing Lens 5 with negative focal length (negative refractive power), and Surface 11 with positive curvature radius

(paraxial concave image-side). *Id.* (citing Ex. 1004, Table 23; Ex. 1003 ¶ 241).

Petitioner further contends that Lens 5 has off-axial convex shapes on its image-side because “more than one inflection point is formed on . . . the image-side surface 1252 of the fifth lens element 1250.” Pet. 80 (citing Ex. 1004 ¶ 194; Ex. 1003 ¶ 242) (emphasis omitted, alteration in original). Petitioner contends that Chung’s Figure 12A shows Lens 5’s image-side with a paraxial concave shape and off-axial convex shapes. *Id.* (citing Ex. 1004, Fig. 12A; Ex. 1003 ¶ 243). Petitioner contends that plotting Surface 11’s aspheric coefficients in ZEMAX confirms Lens 5 has off-axial image-side convex shapes. *Id.* at 80–81 (citing Ex. 1004, Tables 23–24; Ex. 1003 ¶ 244). Petitioner contends that the fifth lens maintains these characteristics post-optimization. *Id.* at 82 (citing Ex. 1003 ¶ 245).

Limitation [1.7] recites “wherein the imaging optical lens assembly has a total of five lens elements.” Petitioner contends that Chung’s Figure 12A shows an imaging optical lens assembly with five lens elements. Pet. 82 (citing Ex. 1004, Fig. 12A; Ex. 1003 ¶ 246).

Limitation [1.8] recites “wherein a curvature radius of the object-side surface of the first lens element is $R1$, a curvature radius of an object-side surface of the second lens element is $R3$, a curvature radius of an image-side surface of the second lens element is $R4$, a focal length of the imaging optical lens assembly is f , a focal length of the third lens element is $f3$, a focal length of the fifth lens element is $f5$, and the following conditions are satisfied: $|R4/R3| < 1.0$; $f5/f3 < 1.0$; $-10.0 < R1/f < 0$.” Petitioner contends that Chung Embodiment 12 has $|R4/R3|$ of 0.2807 and $f5/f3$ of 0.197, satisfying

$|R4/R3| < 1.0$ and $f5/f3 < 1.0$. Pet. 83 (citing Ex. 1004, Table 23; Ex. 1003 ¶ 247).

Petitioner contends that while Chung discloses values that result in an $R1/f$ of -25.641, a POSITA would have been motivated to implement Chung Embodiment 12 with $R1/f$ near -3.0 based on Sekine. *Id.* at 84 (citing Sect. X.C; Ex. 1004, Table 23; Ex. 1005 ¶ 14; Ex. 1003 ¶ 248). According to Petitioner, implementing Chung Embodiment 12 with $R1/f$ near -3.0 satisfies $-10.0 < R1/f < 0$, and simultaneously satisfies $|R4/R3| < 1.0$ and $f5/f3 < 1.0$. *Id.* (citing Ex. 1003 ¶ 248).

Petitioner contends that ZEMAX modeling confirms the routine nature of implementing $R1/f$ near -3.0 and the reasonable expectation of success. *Id.* According to Petitioner, post-optimization of Chung Embodiment 12 as modified above using ZEMAX gives $R1/f$ of -2.55; $|R4/R3|$ of 0.28; $f5/f3$ of 0.065, and its lens shapes and power signs do not change. *Id.* (citing Sect. X.C (Table 2); Ex. 1003 ¶ 249).

Petitioner also contends that Sekine embodiments show the routine nature and reasonable expectation of success of satisfying $|R4/R3| < 1.0$; $f5/f3 < 1.0$; $-10.0 < R1/f < 0$. *Id.* (citing Sect. IX.D.1 (Limitation [1.8]); Ex. 1003 ¶ 250)).

Petitioner has shown a reasonable likelihood that a POSITA would have combined Chung Embodiment 12 and Sekine with a reasonable expectation of success, and that the preamble and limitations of claim 1 are disclosed by the combination. Accordingly, Petitioner has established a reasonable likelihood to prevail in showing claim 1 unpatentable as obvious over the combination of Chung Embodiment 12 and Sekine.

4. *Claim 14*

Limitation [14.1] recites “An imaging optical lens assembly, comprising, in order from an object side to an image side.” Petitioner contends that Chung Embodiment 12 discloses this limitation. Pet. 104–05 (citing Sect. X.D.1 (Limitation [1.1])).

Limitation [14.2] recites “a first lens element with negative refractive power having an object-side surface being concave in a paraxial region thereof, and at least one convex shape in an off-axial region on the object-side surface.” Petitioner contends that Chung Embodiment 12 has a “first lens element 1210 with a negative refractive power [having] an object-side surface 1211 being concave near an optical axis.” Pet. 105 (citing Ex. 1004 ¶ 190) (emphasis omitted, alteration in original).

Petitioner contends that Chung’s Figure 12A shows Lens 1’s image-side with off-axial convex shapes. *Id.* (citing Ex. 1003 ¶ 284).

Petitioner contends that plotting Surface 1’s aspheric coefficients in ZEMAX confirms Lens 1 has off-axial image-side convex shapes. *Id.* at 106–07 (citing Ex. 1004, Tables 23–24; Ex. 1003 ¶ 284).

Petitioner contends that the first lens maintains these characteristics post-optimization. *Id.* at 108 (citing Sect. X.C; Ex. 1003 ¶ 285).

Limitation [14.3] recites “a second lens element having positive refractive power. Limitation [14.4] recites “a third lens element.” Limitation [14.5] recites “a fourth lens element having positive refractive power.” Limitation [14.6] recites “a fifth lens element with negative refractive power having an image-side surface being concave in a paraxial region thereof, and at least one convex shape in an off-axial region on the image-side surface.” Limitation [14.7] recites “wherein the imaging optical

lens assembly has a total of five lens elements.” Petitioner contends that Chung Embodiment 12 discloses limitations [14.3] to [14.7]. Pet. 108 (citing Sect. X.D.1 (Limitations [1.3]–[1.7]); Ex. 1003 ¶¶ 286–289).

Limitation [14.8] recites “wherein a curvature radius of an object-side surface of the second lens element is $R3$, a curvature radius of an image-side surface of the second lens element is $R4$, a focal length of the first lens element is $f1$, a focal length of the third lens element is $f3$, a vertical distance between an off-axial critical point on the object-side surface of the first lens element and an optical axis is $Yc11$, a vertical distance between an off-axial critical point on the image-side surface of the fifth lens element and the optical axis is $Yc52$, and the following conditions are satisfied: $|R4/R3| < 2.0$; $f1/f3 < 2.0$; $0.15 < Yc11/Yc52 < 1.20$.”

Petitioner contends that Chung Embodiment 12 has $|R4/R3|$ of 0.2807. Pet. 108 (citing Sect. X.D.1 (Limitation [1.8]); Ex. 1004, Table 23; Ex. 1003 ¶ 290). According to Petitioner, a POSITA also would have understood that obvious implementation—with a low magnitude $R1/f$ as taught by Sekine—to have $f1/f3 < 2.0$ and $0.15 < Yc11/Yc52 < 1.20$. *Id.* (citing Ex. 1003 ¶ 290).

Petitioner contends that ZEMAX modeling confirms this as it shows an exemplary implementation with $|R4/R3| = 0.28$; $f1$ of -16.31mm and $f3$ of -26.8mm, giving $f1/f3$ of 0.61. *Id.* at 109–10 (citing Sect. X.C (Table 1); Ex. 1003 ¶ 290). According to Petitioner, that same modeling shows $Yc11$ of 0.375mm and $Yc52$ of 1.49mm, giving $Yc11/Yc52$ of 0.25. *Id.* (citing Sect. X.C (Table 1); Ex. 1004, Table 24; Ex. 1003 ¶ 291).

Patent Owner argues that Chung Embodiment 12 and Sekine fail to disclose all element recited in claim 14. Prelim. Resp. 47–52. For the same

reasons stated previously, Patent Owner's arguments do not undermine Petitioner's showing for institution. *See* § III.D.5.

Petitioner has shown a reasonable likelihood that a POSITA would have combined Chung Embodiment 12 and Sekine with a reasonable expectation of success, and that the preamble and limitations of claim 14 are disclosed by the combination. Accordingly, Petitioner has established a reasonable likelihood to prevail in showing claim 14 unpatentable as obvious over the combination of Chung Embodiment 12 and Sekine.

5. *Claim 23*

Limitation [23.1] recites “An imaging optical lens assembly, comprising, in order from an object side to an image side.” Limitation [23.2] recites “a first lens element with negative refractive power having an object-side surface being concave in a paraxial region thereof, and at least one convex shape in an off-axial region on the object-side surface.” Limitation [23.3] recites “a second lens element having positive refractive power.” Limitation [23.4] recites a “third lens element.” Petitioner contends that Chung Embodiment 12 discloses limitations [23.1] to [23.4]. Pet. 118 (citing Sects. X.D.1 (Limitations [1.1]–[1.4]), and X.D.14 (Limitations [14.1]–[14.4]); Ex. 1003 ¶ 308).

Limitation [23.5] recites “a fourth lens element with positive refractive power having an image-side being surface being convex in a paraxial region thereof.” Petitioner contends that Chung Embodiment 12 has a “fourth lens element 1240 with positive refractive power [and] an image-side surface 1242 being convex near the optical axis.” Pet. 118 (citing Ex. 1004 ¶ 193) (emphasis omitted, alteration in original). According to Petitioner, Table 23 confirms, disclosing Lens 4 with positive focal length

(positive refractive power), and Surface 9 with negative curvature radius (paraxial convex image-side). *Id.* at 118–19 (citing Ex. 1003 ¶ 309).

Petitioner contends that the fourth lens maintains these characteristics post-optimization. *Id.* at 119 (citing Ex. 1003 ¶ 310; Sect. X.C).

Limitation [23.6] recites “a fifth lens element with negative refractive power having an image-side surface being concave in a paraxial region thereof, and at least one convex shape in an off-axial region on the image-side surface.” Limitation [23.7] recites “wherein the imaging optical lens assembly has a total of five lens elements and further comprises an aperture stop disposed between the first lens element and the second lens element.” Petitioner contends that Chung Embodiment 12 discloses these limitations. Pet. 119–20 (citing Sects. X.D.1 (Limitations [1.6]–[1.7]), X.D.4 (Limitation [4.1]); Ex. 1003 ¶ 311).

Limitation [23.8] recites “wherein a curvature radius of an object-side surface of the second lens element is $R3$, a curvature radius of the image-side surface of the second lens element is $R4$, a focal length of the first lens element is $f1$, a focal length of the third lens element is $f3$, and the following conditions are satisfied: $|R4/R3| < 4.0$; $f1/f3 < 5.0$. Petitioner contends that Chung Embodiment 12 has $|R4/R3|$ of 0.2807, satisfying $|R4/R3| < 4.0$. Pet. 120 (citing Sect. X.D.1 (Limitation [1.8])). Petitioner contends that incorporating $R1/f_{\text{near}} - 3.0$, followed by optimization, results in $f1/f3$ of 0.61. *Id.* (citing Sects. X.C, X.D.14 (Limitation [14.7]); Ex. 1003 ¶ 312).

Petitioner further contends that Chung Embodiment 1 and Sekine Embodiments 1, 2, 5, and 6 also simultaneously satisfy $|R4/R3| < 4.0$; $f1/f3 < 5.0$. *Id.* (citing Sect. IX.D.23 (Limitation [23.8]); Ex. 1003 ¶ 313).

Patent Owner argues that Chung Embodiment 12 and Sekine fail to disclose all elements recited in claim 23. Prelim. Resp. 53. For the same reasons stated previously, Patent Owner's arguments do not undermine Petitioner's showing for institution. *See* § III.D.6.

Petitioner has shown a reasonable likelihood that a POSITA would have combined Chung Embodiment 12 and Sekine with a reasonable expectation of success, and that the preamble and limitations of claim 23 are disclosed by the combination. Accordingly, Petitioner has established a reasonable likelihood to prevail in showing claim 23 unpatentable as obvious over the combination of Chung Embodiment 12 and Sekine.

6. *Remaining Dependent Claims*

Petitioner contends claims 2–7, 9–13, 15–22, and 24–27 would have been obvious in light of the combination of Chung Embodiment 12 and Sekine and provides evidence and reasoning supporting its contentions. Pet. 84–104, 110–117, 120–125. Patent Owner does not separately dispute Petitioner's contentions for these claims. We determine Petitioner has presented sufficient evidence to establish that the combination of Chung Embodiment 12 and Sekine teaches the limitations of the remaining challenged claims.

IV. CONCLUSION

Petitioner has demonstrated a reasonable likelihood of prevailing in showing the unpatentability of at least one challenged claim of the '519 patent. At this stage of the proceeding, however, we have not made a final determination with respect to the patentability of the challenged claims.

V. ORDER

For the foregoing reasons, it is

ORDERED that, pursuant to 35 U.S.C. § 314(a), an *inter partes* review of claims 1–27 of the '519 patent is instituted with respect to all grounds of unpatentability set forth in the Petition; and

FURTHER ORDERED that, pursuant to 35 U.S.C. § 314(c) and 37 C.F.R. § 42.4(b), *inter partes* review of the '519 patent shall commence on the entry date of this Order, and notice is hereby given of the institution of a trial.

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