

Filed on behalf of: Savant Techs. LLC d/b/a GE Lighting, Elong Int'l USA Inc., and
Xiamen Longstar Lighting Co. Ltd.

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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

**SAVANT TECHNOLOGIES LLC d/b/a GE LIGHTING,
ELONG INTERNATIONAL USA INC., AND
XIAMEN LONGSTAR LIGHTING CO. LTD.**

Petitioners,

v.

FEIT ELECTRIC COMPANY, INC.,

Patent Owner.

Case No. IPR2025-00260

Patent No. 8,604,678

**PETITION FOR INTER PARTES REVIEW
OF U.S. PATENT NO. 8,604,678 (CLAIMS 11-14)**

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LISTING OF CHALLENGED CLAIMS

1. A wavelength conversion component for a light emitting device comprising:
 - a wavelength conversion layer comprising particles of at least one photoluminescence material; and
 - a light diffusing layer comprising particles of a light scattering material,wherein the light diffusing layer improves an off-state white appearance of the wavelength conversion component;

wherein the wavelength conversion component is configured such that in operation a portion of excitation light comprising blue light having a wavelength of greater than or equal to 440 nm generated by the light emitting device is emitted through the wavelength conversion component to contribute to a final visible emission product.
11. The component of claim 1, wherein the light scattering material has an average particle size that is selected such that the light scattering material will scatter the excitation light relatively more than the light scattering material will scatter light generated by the at least one photoluminescence material.
12. The component of claim 11, wherein the light scattering material scatters the excitation light at least twice as much as light generated by the at least one photoluminescence material.
13. The component of claim 11, wherein the excitation light comprises blue light.
14. The component of claim 13, wherein the light scattering material has an average particle size that is less than about 150 nm.

Savant Technologies LLC d/b/a GE Lighting, Elong International USA Inc., and Xiamen Longstar Lighting Co. Ltd. (“Petitioners”) request *inter partes* review of U.S. Patent No. 8,604,678 (“the ’678 patent”) (EX1001) under 35 U.S.C. § 311 *et seq.* and 37 C.F.R. Part 42. Petitioners’ request is supported by the testimony of Professor Alan Doolittle (EX1002; EX1003; EX1022), and other corroborating exhibits. This petition shows there is a reasonable likelihood that at least one of claims 1 and 11-14 of the ’678 patent is unpatentable for failure to satisfy pre-AIA 35 U.S.C. § 103.

I. RELATIONSHIP TO IPR2024-01357 (*General Plastic* factors)

Savant filed a prior petition requesting *inter partes* review of the ’678 patent on August 26, 2024, which has been assigned case no. IPR2024-01357. This petition challenges the previously unchallenged claims 11 and 12, which have been newly asserted against Savant¹ in district court, and the related claims 13 and 14. Accordingly, it also challenges independent claim 1, from which all those claims ultimately depend. Relevant sections of this petition, particularly the introduction and the challenges to independent claim 1, are *verbatim* copies of the

¹ Patent Owner has not asserted these claims against Ledvance, the other petitioner in IPR2014-01357.

corresponding sections of the petition in IPR2024-01357.²

Savant's petition in IPR2024-01357 challenged all of the claims then asserted against it. At the time it filed its petition, Savant did not anticipate that Patent Owner would assert additional claims against it.³ The purpose of this petition is to challenge the newly asserted claims 11 and 12—as well as the related and also previously unchallenged claims 13 and 14—using the same prior art. So this petition is directed to a set of claims that are non-overlapping with those challenged in IPR2024-01357. (The mapping of claim 1 is re-presented here only for purposes of completeness in reaching the dependent claim features of claims 11-14.)

Thus, institution is supported by the *General Plastic* factors and the Board's proposed rules. *See General Plastic Industrial Co., Ltd. v. Canon Kabushiki Kaisha*, No. IPR2016-01357, Paper 19 (Sept. 6, 2017) (precedential); *see also* Notice of Proposed Rulemaking, Patent Trial and Appeal Board Rules of Practice for Briefing Discretionary Denial Issues, and Rules for 325(d) Considerations,

² Substantive new content is limited to the background regarding the new claims of Section VII and the challenges to dependent claims 11-14 in Sections IX and X.

³ Patent Owner's assertion of new claims was without leave, a good faith basis, or a proper purpose.

Instituting Parallel and Serial Petitions, and Termination Due to Settlement Agreement, 89 Fed. Reg. 28693 (April 19, 2024) (incorporating *General Plastic* factors). The assertion of additional claims by Patent Owner is good cause for instituting this petition directed to those newly asserted claims.

In particular, with respect to the *General Plastic* factors, this petition is directed to newly-asserted and previously-unchallenged claims, so Petitioners have not “previously filed a petition directed to the same claims of the same patent.” See *General Plastic*, Paper 19 at 16 (first and fifth factors). This petition does not rely on any new prior art, but rather the same prior art (and arguments) as used to challenge the claims in IPR2024-01357. See *id.* (second and fourth factors). The preliminary response in IPR2024-01357 has not yet been filed and no institution decision has been issued. See *id.* (third factor). And as explained above, this petition is in response to Patent Owner asserting new claims against Savant after the filing of the petition in IPR2024-01357, justifying the time elapsed between the two petitions. See *id.* (fifth factor). Given that this petition applies the same prior art and arguments, including identical challenges with respect to independent claim 1, institution will not burden the Board’s resources or delay issuance of a final determination. See *id.* (sixth and seventh factors). Petitioner also suggests consolidation of this IPR together with IPR2024-01357 and will work to reconcile

the corresponding trial schedules as necessary to avoid any adverse impact on PTAB resources.

For all these reasons, the Board should exercise its discretion to institute *inter partes* review based on this petition.

II. INTRODUCTION

Today's LED light bulbs use LED light sources made up of LEDs that generate blue light and phosphors that convert some of that blue light to longer wavelengths so that the combined light appears white. (EX1002, ¶¶44-52, 65-69.) When off, such white-light LED light sources are yellow in color. (*Id.*) The challenged claims are generally directed to white-light LED light sources that have an outer layer containing titanium dioxide particles ("TiO₂ particles," i.e., white pigment particles) so that when the LED light source is off, it will appear less yellow and more white. During prosecution, the applicants distinguished the examiner-cited prior art because it did not disclose a white-light LED light source using a blue LED. The applicants never informed the Examiner that the use of a light diffusing layer containing TiO₂ particles in a white-light LED light source was disclosed in the prior art. (EX1004.) Indeed, the applicants borrowed a prior art figure to teach this very feature in their specification.

The use of a light diffusing layer containing TiO₂ particles with a white-light LED light source was known for years before the earliest filing date of the '678

patent. (EX1002, ¶¶53-64, 70-74.) There are numerous prior art references that disclose the use of TiO₂ with white-light LED light sources. (See, e.g., EX1005 (Basin-2007), EX1007 (Krummacher), EX1010 (Shimizu), EX1008 (Stokes).) One such prior art reference serves as the basis for Figure 10 of the '678 patent, which seems to have been lifted directly from DuPont marketing materials for TiO₂. (EX1012, fig.4; EX1013, fig.7.)

Basin-2007 and Krummacher render obvious the challenged claims together with secondary references teaching well-known implementation details of such white-light LED light sources such as the wavelength of blue light and the use of silicone as a binder, both of which are well-known in the art as shown by Basin-2005, Shimizu, and Stokes.

Accordingly, *inter partes* review should be instituted and the challenged claims canceled.

A. U.S. Patent No. 8,604,678

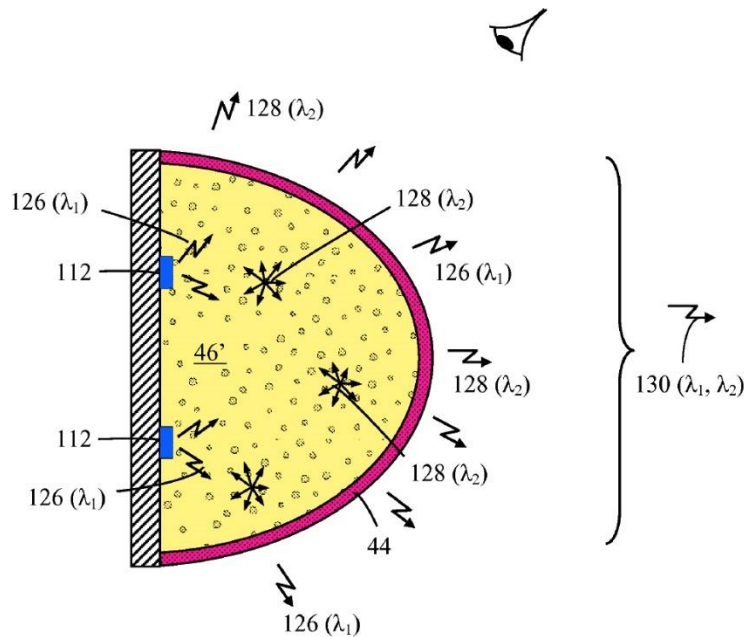


FIG. 18

EX1001, Annotated Figure 18

The '678 patent is entitled "Wavelength Conversion Component with a Diffusing Layer." The disclosed wavelength conversion component with a diffusing layer is configured to be used with a blue-light LED and other components to create a white-light LED light source. (See also EX1002, ¶¶75-78.) The '678 patent claims broadly cover a white-light LED light source with a light diffusing layer containing TiO₂ particles. (See, e.g., EX1001, claim 1.)

B. Prosecution History

The '678 patent issued from U.S. Pat. Appl. No. 13/273,212. (EX1004.) It

claims priority to U.S. Provisional Pat. Appl. Nos. 61/390,091, filed October 5, 2010, and 61/427,411, filed December 27, 2010. (*See also* EX1002, ¶¶79-82.)⁴

During prosecution, the only prior art reference applied by the Examiner against the independent claims for the “light diffusing layer” was U.S. Pat. Pub. No. 2002/0180351 to McNulty. The applicants distinguished McNulty on the basis that it (1) was not configured like a white-light LED light source (EX1004, pp.150-55), and (2) indeed, taught an ultraviolet (i.e., not visible light) LED chip unsuitable for a white-light LED light source (EX1004, pp.200-03).

With respect to the ***first*** distinction, the applicants amended the claims to require the configuration used by white-light LED light sources, which, as discussed below, mix blue light emitted directly from a blue-light LED chip with yellow light emitted by phosphors which are excited by the blue light (and appear yellow when the LED light source is off). (EX1004, p.145.) The relevant requirements with respect to claim 1 are underlined once below. With respect to the ***second*** distinction, the applicants amended the claims to specifically require the blue light generated by a blue-light LED chip. (EX1004 p.194.) That amendment is underlined twice below.

⁴ As the art applied herein predates the earliest alleged filing date, the legitimacy of the priority claim need not be assessed.

1. A wavelength conversion component for a light emitting device comprising:
a wavelength conversion layer comprising particles of at least one photoluminescence material; and
a light diffusing layer comprising particles of a light scattering material,
wherein the light diffusing layer improves an off-state white appearance of the wavelength conversion component;
wherein the wavelength conversion component is configured such that in operation a portion of excitation light comprising blue light having a wavelength of greater than or equal to 440 nm generated by the light emitting device is emitted through the wavelength conversion component to contribute to a final visible emission product.

The applicants convinced the Examiner that it would not have been obvious to use a light diffusing layer with a phosphor-converted white-light-emitting light source utilizing blue LEDs. (EX1004, p.1151 (citing pp.1053-57).) The applicants never informed the Examiner that the use of a TiO₂-containing light diffusing layer in such a white-light LED light source was disclosed in the prior art.

C. Level of Skill in the Art

1. Qualifications of a POSA

The '678 patent describes the alleged invention as “relat[ing] to solid-state light emitting devices that use a ... phosphor wavelength conversion component to

generate a desired color of light.” Accordingly, a POSA would have had an undergraduate degree (i.e., B.S., B.S.E. or the equivalent) in electrical engineering, materials science, physics, or a similar discipline. A POSA would also have one to two years of experience in the field of LED packaging design. More education could substitute for experience, and vice versa. This person would have been capable of understanding and applying the teachings of the ’678 patent and the prior-art references discussed herein. Moreover, the prior art reflects the level of skill at the time of the claimed invention. *See Okajima v. Bourdeau*, 261 F.3d 1350, 1355 (Fed. Cir. 2001). (*See also* EX1002, ¶¶38-42.)

2. Technological Background

a. Blue-light LED chips led to white-light LED light sources

As reflected in the Background of the ’678 patent, the development of high-efficiency blue-light LED chips eventually led to white-light LED light sources that could replace fluorescent and incandescent light sources. (EX1001, 1:30-46; *see also* EX1002, ¶¶65-69.) Citing Shimizu-APA, the ’678 patent discussed the structure and operation of white-light LED sources thusly:

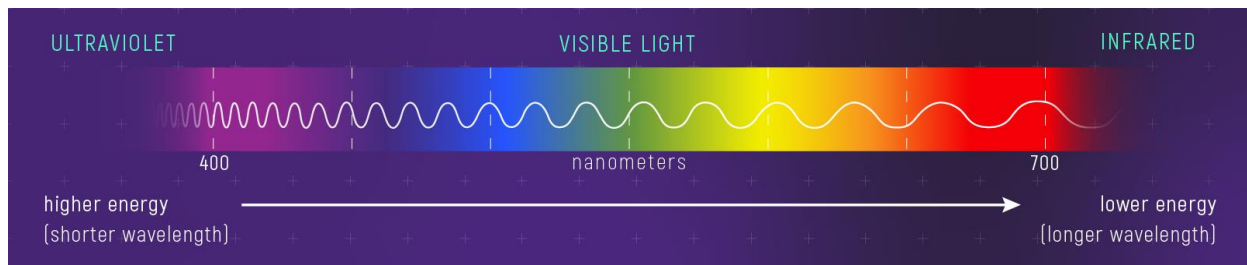
Typically, the LED chip or die generates blue light and the phosphor(s) absorbs a percentage of the blue light and re-emits yellow light The portion of the blue light generated by the LED that is not absorbed by the phosphor

material combined with the light emitted by the phosphor provides light which appears to the eye as being nearly white in color.

(EX1001, 1:38-46.)

As described in Shimizu and elsewhere, LED chips convert electricity to light very efficiently, but they emit monochromatic light in a relatively narrow wavelength range. (See EX1002, ¶¶50, 66.)

Phosphors convert light by absorbing light at one wavelength and emitting it at another. Because blue light is at the higher frequency end of the visible light spectrum (e.g., ~440 nm), it also has higher energy than other visible light. Thus, there are phosphors that will convert higher energy blue light to a lower energy light like yellow light. (EX1002, ¶67.)



NASA, ESA, STScI (available at <https://perma.cc/QM4N-WPKS>)

The light output by a typical white-light LED light source is the sum of the yellow light emitted by the phosphors and the unabsorbed blue light emitted by the LED chip. In 1999, Shimizu demonstrated this through three charts (Figures 19A-C) have been annotated below to indicate 440 nm (as specified in the claims of the

'678 patent) and shade the visible blue light range from 440 nm to about 490 nm.
(EX1002, ¶68.)

Figure 19A shows the relative intensity of the yellow light emitted by the phosphors. Figure 19B shows the relative intensity of the blue light emitted by the LED chip, which has a peak at 450nm. Finally, Figure 19C shows the relative intensity of the white light that reflects the contribution at 450nm of the blue light emitted by the LED chip and not absorbed by the phosphors. (EX1002, ¶69.)

Fig. 19A

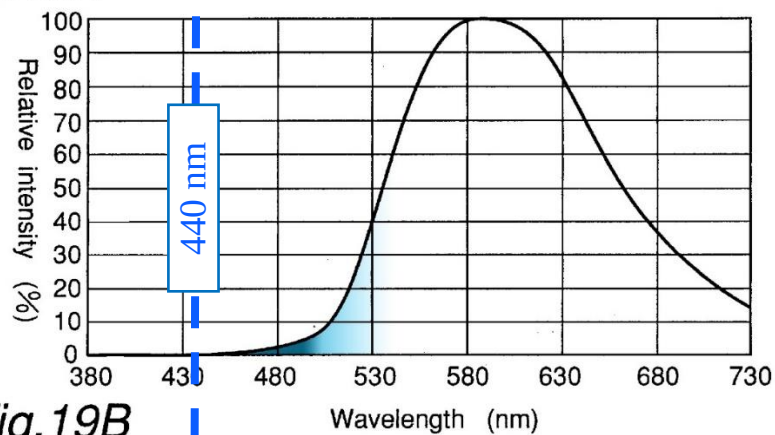


Fig. 19B

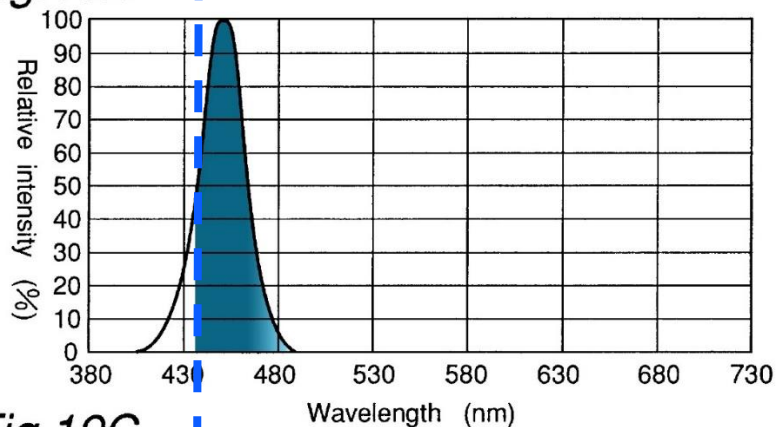
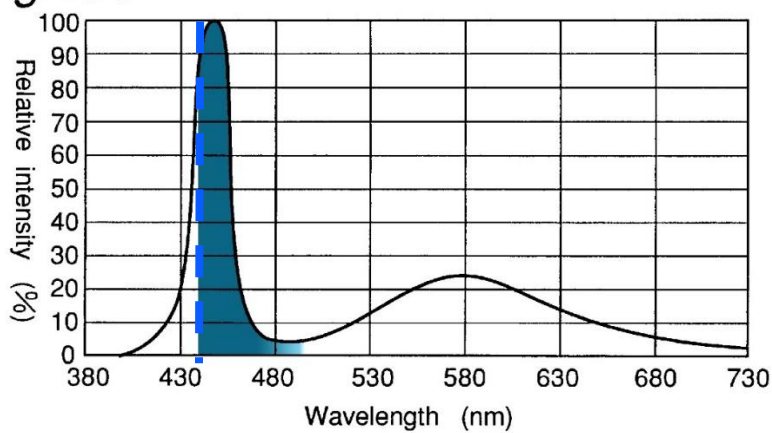


Fig. 19C



Shimizu-APA, Annotated Figures 19A-19C

b. White-light LED light sources were improved with a TiO₂-containing light diffusing layer

By 2010, the earliest filing date of the '678 patent, it was well-known to use a light diffusing layer, such as a layer containing TiO₂ particles, in white-light LED light sources to diffuse light and to obtain an off-state white appearance in the LED package. (See EX1002, ¶¶70-74.)

Because the phosphors described above absorb blue light and emit yellow light, they will absorb ambient blue light and emit a small amount of yellow light even when the LED light source is off. This gives the phosphors a yellow-to-orange appearance. In one application, blue LEDs mounted on a substrate are covered in phosphor-containing silicone in order to mimic the appearance of the filament in a traditional incandescent light bulb. Such LED “filaments” appear yellow when unlit (off) due to the presence of the phosphor coating. (EX1002, ¶71.)

Once white-light LED light sources were developed and employed in LED light bulbs and other lighting devices, artisans realized that some consumers found the yellow color of the phosphor layer in the off-state undesirable. To improve that appearance, artisans used a light diffusing layer containing TiO₂ particles to obscure the yellow body color of the phosphor converter and make it appear whiter when turned off. (E.g., EX1005, ¶[0004]; EX1007, ¶[0004]; EX1019, 1:28-35 (“in

many applications a colored appearance of a light source in the off-state is undesired, techniques have been developed to produce LED based illumination devices having a neutral, e.g. white or whitish, appearance in the off-state”); EX1020, 5:29-30 (“it is this yellowish appearance of the pc-LED under ambient lighting conditions that is disturbing in many application areas”).) This knowledge in the art is reflected in the prior art references discussed below. (EX1002, ¶¶73-74.)

D. Summary of Asserted References

1. Basin-2007 (Pub. No. US2009/0057699; EX1005)

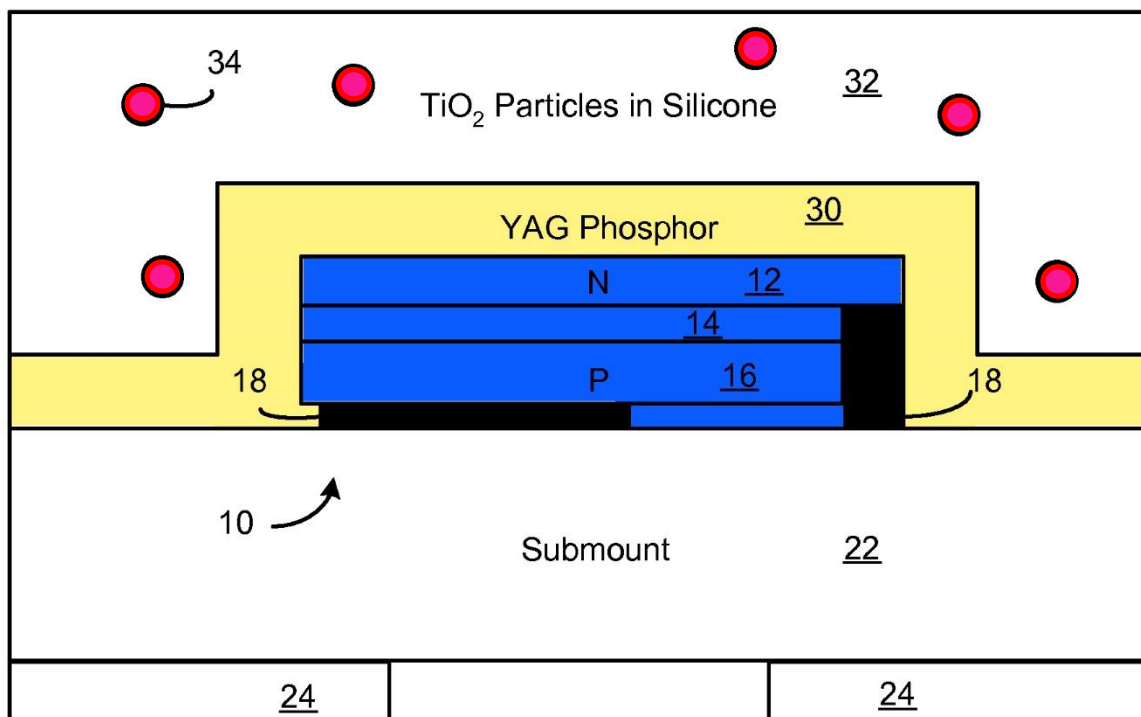


Fig. 2

Basin-2007, Annotated Figure 2

U.S. Patent Publication No. US2009/0057699 to Basin (“Basin-2007”), filed on September 4, 2007, and published on March 5, 2009 (EX1005), is prior art under pre-AIA 35 U.S.C. § 102(b). (See also EX1002, ¶¶92-94.)

As shown in the annotated Figure 2 above, Basin-2007 discloses a blue-light LED chip (12, 14, 16), a phosphor-containing wavelength conversion layer (30), and a light diffusing layer containing TiO_2 particles (32) for improving “Non-Yellow Off State Color.”

2. Krummacher (Pub. No. US 2008/0079015; EX1007)

FIG 1

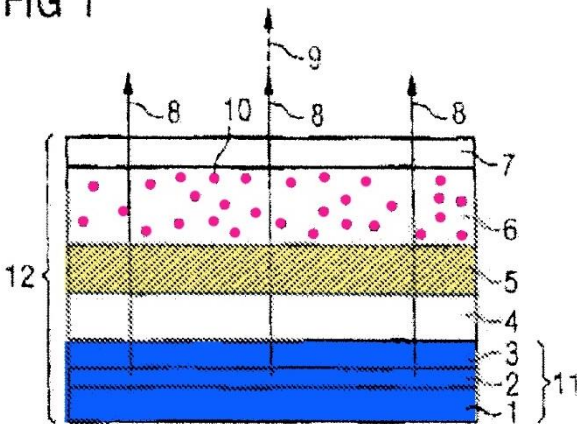
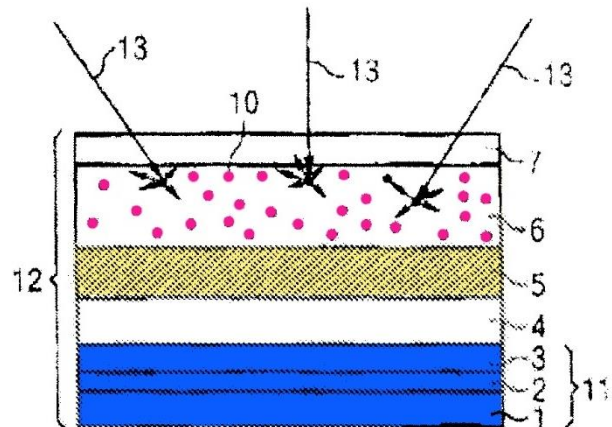


FIG 2

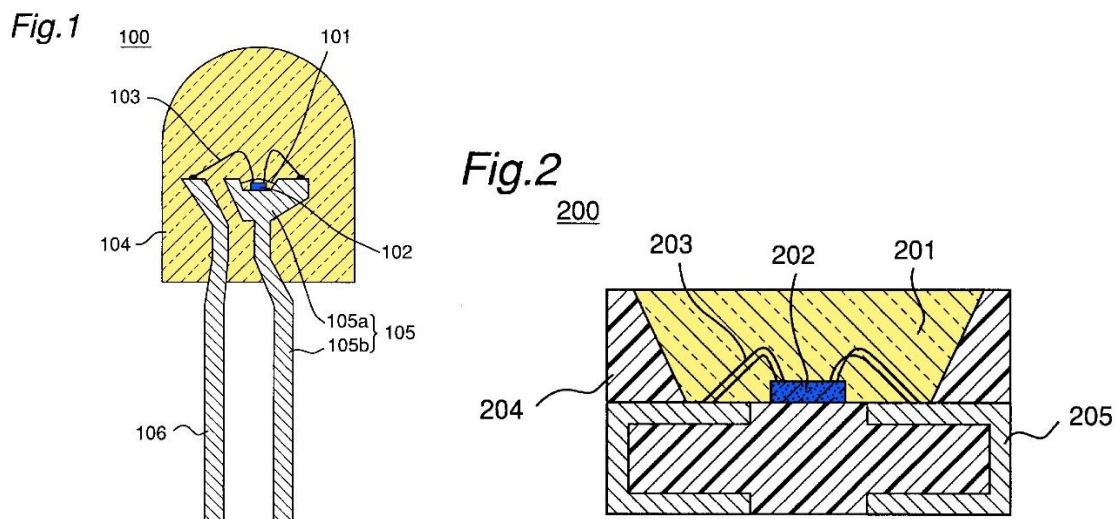


Krummacher, Annotated Figures 1-2

U.S. Patent Publication No. US 2008/0079015 A1 to Krummacher, filed on September 18, 2007, and published on April 3, 2008 (EX1007), Krummacher is prior art under pre-AIA 35 U.S.C. § 102(b). (See also EX1002, ¶¶95-97.)

As shown in the annotated figures above, Krummacher also discloses a white-light LED light source with a blue-light LED chip (11) with an encapsulant layer (4), a phosphor-containing wavelength conversion layer (5), a particle-containing light diffusing layer (6), and a cladding layer (7). (EX1007, ¶¶[0033], [0036], [0038], [0039].) Figure 1 shows the white-light LED light source in the ON state, where the blue light from the LED chip (11) combines with the yellow light from the phosphor layer (5) to create a white-appearing light. (EX1007, ¶¶[0031], [0036].) Figure 2 shows that the light-diffusing layer (6) (containing, for example, TiO₂ particles) obscures any yellow light color from the phosphor layer (5) when the light source is in the OFF state. (EX1007, ¶¶[0031], [0039], [0041].)

3. Shimizu (Pat. No. 6,069,440; EX1010) and Shimizu-APA (Pat. No. 5,998,925; EX1009)



Shimizu, Annotated Figures 1-2

U.S. Patent Nos. 5,998,925 (“Shimizu-APA”) (EX1009) and 6,069,440 (“Shimizu”) (EX1010), a divisional of Shimizu-APA, share a common disclosure and are prior art under pre-AIA 35 U.S.C. § 102(b). Shimizu-APA is admitted prior art to the ’678 patent. (EX1001, 1:34-38.) Shimizu is incorporated by reference into Stokes. (*See also* EX1002, ¶¶101-04.)

Shimizu discloses a white-light LED light source that uses a blue LED and a diffusing layer to improve its OFF-state color, e.g.:

According to the present invention, adding the dispersant and/or a coloration agent in the molding material has the effects of masking the color of the fluorescent material That is, the fluorescent material absorbs blue component of extraneous light and emits light thereby to [appear] yellow. However, the **dispersant** contained in the molding material gives **milky white color** to the molding material and the coloration agent renders a desired color. **Thus the color of the fluorescent material will not be recognized by the observer.**

(EX1010, 17:25-35 (emphasis added).)

Shimizu further states that the disclosed white-light LED light source can be used in a wide variety of applications including general lighting applications. In particular, Shimizu discloses use of its white-light LED in buoys for harbors and

ports, as well as outdoor use in signage and illumination for expressways.

(EX1010, 31:11-16.)

The '678 patent applicants did not inform the Examiner that Shimizu disclosed a white-light LED light source with the claimed light diffusing layer when discussing it in the Background section of their own application.

III. STANDING CERTIFICATION (37 C.F.R. § 42.104(a))

The '678 patent is available for *inter partes* review. Petitioners are not barred or estopped from requesting *inter partes* review on the identified grounds.

IV. MANDATORY NOTICES (37 C.F.R. § 42.8(b))

A. Real Parties-in-Interest (§ 42.8(b)(1))

- Seoul Semiconductor Co. Ltd.
- Ledvance is not a Real Party-in-Interest, but it does have a business relationship with Seoul Semiconductor Co. Ltd. and is identified here for Board assessment of internal conflicts of interest.

B. Related Matters (§ 42.8(b)(2))

Patent Owner has asserted the '678 patent in the following actions:

- *Feit Electric Co., Inc. v. Ledvance, LLC*,
No. 5:24-cv-31 (E.D. Ky. filed Feb. 2, 2024).
- *Feit Electric Co., Inc. v. Savant Technologies LLC d/b/a GE Lighting*,
No. 1:24-cv-473 (N.D. Ohio filed Mar. 13, 2024).

- *Feit Electric Co. Inc v. Elong International USA Inc., et al.*,
No. 3:24-cv-1089 (N.D. Tex. filed May 6, 2024).

The '678 patent has been challenged in the following proceedings:

- *Savant Techs. LLC d/b/a GE Lighting et al. v. Feit Elec. Co, Inc.*,
IPR2024-01357 (PTAB filed Aug. 26, 2024).
- Contemporaneously with this petition, Elong and Xiamen Longstar
are filing a “me-too” petition seeking joinder to IPR2024-01357.

C. Lead and Back-Up Counsel (§ 42.8(b)(3))

Lead Counsel: David C. Radulescu, Ph.D. (reg. no. 36,250).

Back-Up Counsel: Andrew S. Brown (reg. no. 74,177),

Etai Lahav (*provisionally-recognized PTAB attorney*).

D. Service Information (§ 42.8(b)(4))

Petitioners consent to electronic service.

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V. IDENTIFICATION OF CHALLENGE (37 C.F.R. § 42.104(b))

Petitioners request review of claims 1 and 11-14 of the '678 patent under
35 U.S.C. § 311. The grounds are as follows.

Ground	Claims	Description
1	1	Obvious over Basin-2007 in view of Basin-2005 ⁵ (duplicate of IPR2024-01357 ground)
2	11-14	Obvious over Basin-2007 in view of Basin-2005 and Stokes ⁶
3	1, 11-14	Obvious over Krummacher in view of Shimizu and Stokes (duplicate of IPR2024-01357 ground with respect to independent claim 1)

VI. CLAIM CONSTRUCTION

Claims should be understood according to their ordinary and customary meaning as understood by a POSA at the time of the invention considering the language of the claims, the specification, and the prosecution history of record. 37 C.F.R. §42.100; *Phillips v. AWH Corp.*, 415 F.3d 1303, 1312-14 (Fed. Cir. 2005) (*en banc*). The Board need construe claims only to the extent necessary to

⁵ U.S. Patent Publication No. US2007/0045761 to Basin (“Basin-2005”), was filed on August 26, 2005 and published on March 1, 2007 (EX1006), is prior art under pre-AIA 35 U.S.C. § 102(b). (*See also* EX1002, ¶¶89-91.)

⁶ U.S. Patent No. 6,791,259 to Stokes, filed on August 22, 2000 and issued on September 14, 2004 (EX1008), is prior art under pre-AIA 35 U.S.C. § 102(b). (*See also* EX1002, ¶¶98-100.)

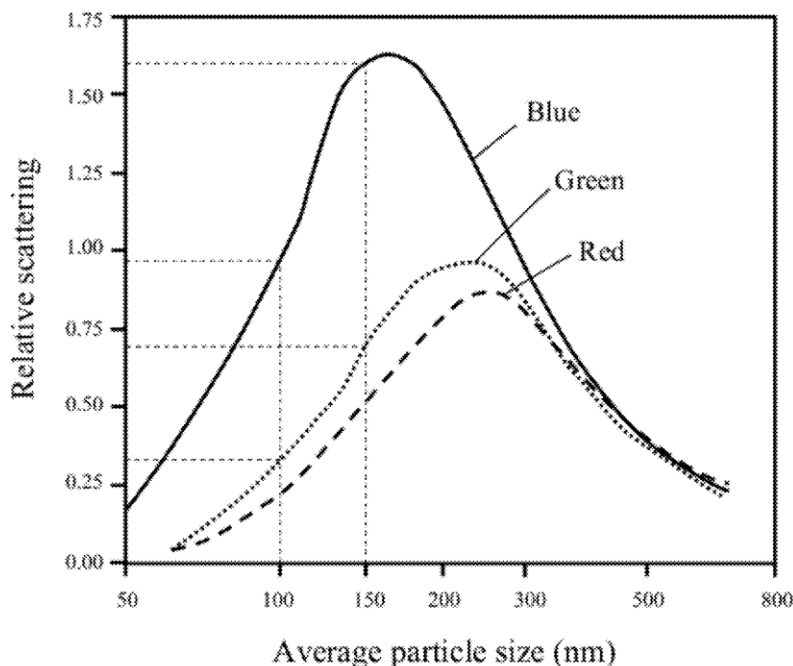
resolve a patentability controversy. *Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co. Matal*, 868 F.3d 1013, 1017 (Fed. Cir. 2017). Petitioners submit that no construction should be necessary to institute this petition. (*See also* EX1002, ¶¶83-86.) Petitioners reserve the right to argue different constructions in any other actions involving the '678 patent.

VII. BACKGROUND REGARDING NEW CLAIMS

The newly-asserted and newly-challenged claim 11 depends from claim 1 and further requires an “average particle size” that scatters relatively more of the “excitation light” generated by the LED (e.g., blue light) than the converted light “generated by the at least one photoluminescence material” (e.g., yellow light). Claims 12, 13, and 14 all depend from claim 11 and cover subsets of average particle sizes or the use of a blue-light LED chip.

These claims relate to the unattributed and theoretical disclosure in the '678 patent that the size of the particles in the light scattering material could be selected to scatter more blue light than red or green light. (EX1001, 11:37-12:12.) The alleged benefits include more efficient conversion of the blue light generated by the LED chip. (*Id.*) This disclosure is supported by Figure 10, which purports to show “plots of relative light scattering versus TiO₂ average particle size (nm) for red, green and blue light.” (*Id.*) As mentioned briefly above and discussed in more

detail here, Figure 10 appears to have been lifted directly from prior art DuPont research and marketing materials for TiO₂ without attribution. (See EX1022, ¶26.)



'678 Patent, Figure 10

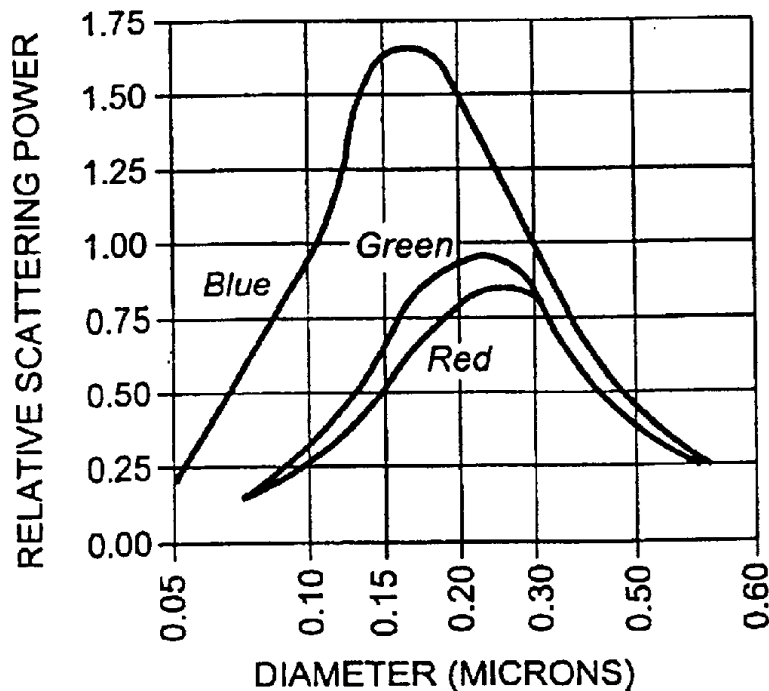
In May 1997, two DuPont researchers, Erik S. Thiele and Roger H. French, presented the paper “Light-Scattering Properties of Representative, Morphological Rutile Titania Particles Studied Using a Finite-Element Method.” (EX1015.) Until then, the light-scattering properties of TiO₂ particles had been modeled using Mie theory, which was overly simplistic and had significant limitations. (*Id.*, p.469) Accordingly, the paper proposed a finite-element method to theoretically determine the light-scattering properties of certain types of TiO₂ particles. (*Id.*) Among other things, this finite-element method depended on the “wavelength of

interest.” (*See, e.g., id.*, p.471 (“The wavelength of interest for tint strength tests of paint films is 560 nm, the center of the visible spectrum. This wavelength is used in the computations performed throughout this study.”).) In other words, it could be used to model the light-scattering properties of certain types of TiO₂ for selected wavelengths of light. (EX1022, ¶¶27-28.)

U.S. Patent No. 6,791,259 to Stokes was filed on August 22, 2000, issued on September 14, 2004, and was assigned to the General Electric Company (EX1008). Stokes provides a figure labeled “prior art”⁷ (fig. 6, shown below) that uses the DuPont finite-element method to “illustrate[] the relationship between the particle diameter and the wavelength of the scattered light for Ti-Pure[®] rutile TiO₂ particles made by DuPont.” (*Id.*, 7:7-9; *see also* EX1022, ¶¶29-30.) Stokes applies this information to a white-light LED light source to suggest preferentially scattering “blue radiation (i.e., such as that emitted by a blue emitting LED)” as compared to “green or red (or for that matter yellow) radiation (i.e., such as that emitted by the phosphor or dye).” (*Id.*, 7:1-26.) In particular, Stokes explains that selecting an

⁷ It is unclear if the figure was provided by DuPont originally or if it was created by the General Electric engineers using the DuPont model. Based on similarity to later marketing materials, it appears to be derived from early DuPont marketing materials.

appropriate particle size “enhances the scattering of the radiation source radiation while it decreases the amount of scattering of the luminescent material radiation” such that “the lamp radiation output is rendered more uniform because a greater amount of radiation source radiation is scattered toward the luminescent material[.]” (*Id.*, 7:10-26.)



Stokes (EX1008), Figure 6

Research papers were also published during the relevant time period containing a similar graph. For example, a paper (EX1023) was presented at the RadTech e|5 2006 conference containing the following figure.

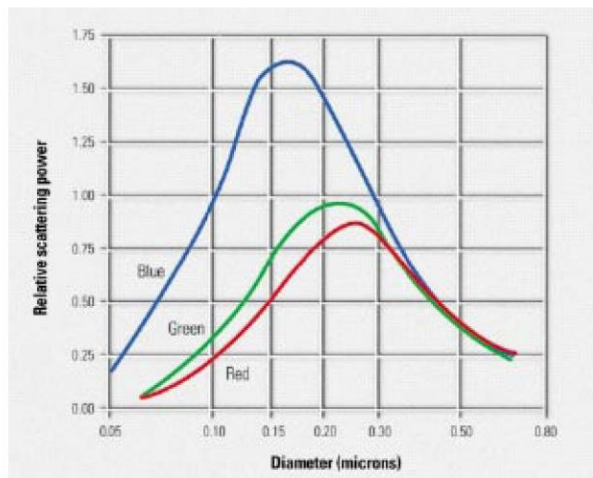


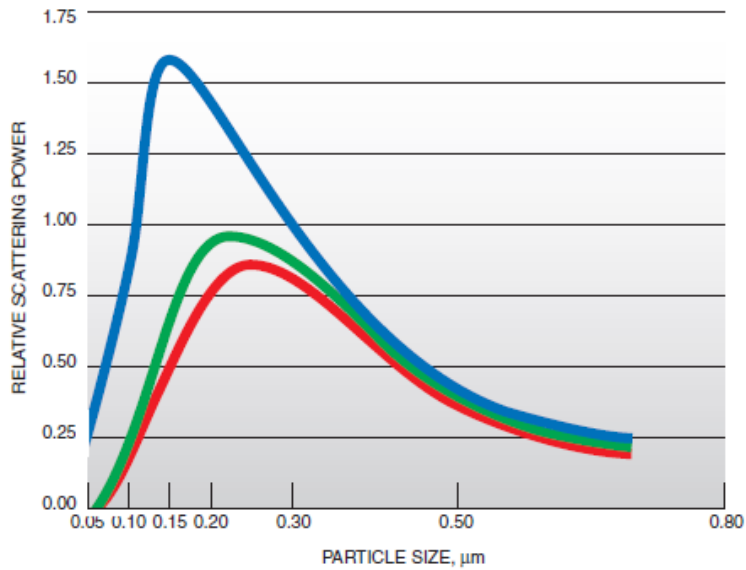
Figure 5. Relationship between TiO₂ particle size and light scattering (Courtesy: Dupont Titanium Technologies).

Consistent with Stokes citing the DuPont web page as it appeared in 2000 (“DuPont Ti-Pure Titanium Dioxide Web Page,” DuPont Home Page, visited Aug. 3, 2000) and other references crediting DuPont, a graph similar to Figure 6 of Stokes was widely distributed in DuPont marketing materials for TiO₂ that were published in 2007. (EX1022, ¶32.) As the marketing materials explain, the graph is “derived from theoretical considerations in highly dilute systems [and] show[s] the relative scattering power of rutile⁸ TiO₂ for blue, green and red light as a function of particle size.” (EX1012, p.4; EX1013, p. 8.)

⁸ Titanium dioxide comes in various forms (in other words, polymorph forms having the same chemical formula: TiO₂). The “rutile” form is the most common

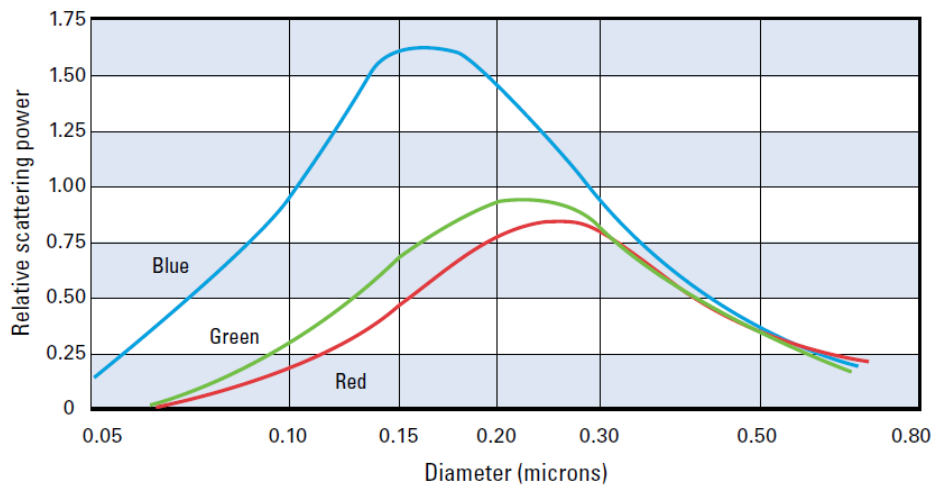
(cont.)

Figure 4. Relative Light Scattering Power vs. Rutile Particle Size



DuPont: Polymers, Light and the Science of TiO₂ (2007) (EX1012), p.4

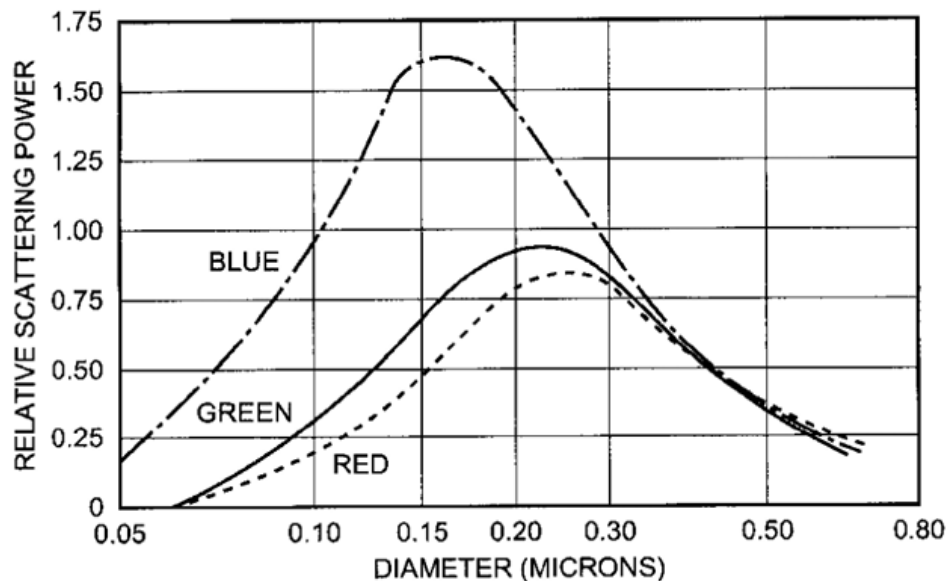
Figure 7. Relative Light Scattering Power versus Rutile Particle Size.



DuPont: Titanium Dioxide for Coatings (2007) (EX1013), p.8

natural form and is thus the form studied by Dupont in their early theoretical work cited above.

U.S. Patent Application No. 12/498,253 to Toquin was filed on July 6, 2009, published as Pub. No. 2011/0001151 on January 6, 2011, and was assigned to Cree, Inc. (EX1024). Toquin provides a similar figure “showing the relative light scattering power vers[u]s the scattering particle size for TiO₂ scattering particles commercially available from different sources, such as from Dupont, Inc.” (EX1024, ¶[0080].)



Toquin (EX1024), Figure 4

These prior art figures are all similar and all either reference DuPont or were published by DuPont. (See EX1022, ¶¶25-34.) Figure 10 of the '678 patent also bears a striking similarity to these prior art figures. (*Id.*) In addition to graphing the same theoretical model, the figures all share certain unusual design decisions, such as using: the same nonlinear or nonstandard scale for the x-axis (particle size) of

the graph;⁹ the same vertical axis scale, 0 to 1.75; and the same data range, from 0.05 microns (50nm) to around 0.65 microns (650 nm). (EX1022, ¶34.)

VIII. [GROUND 1] Claim 1 is rendered obvious by Basin-2007 in view of Basin-2005

Basin-2007 discloses every element in challenged claim 1 with one exception: it does not specifically disclose that the LED chip emits blue light at a wavelength of greater than or equal to 440 nm. But LED chips emitting blue light at this wavelength were well known in the art as evidenced by Basin-2005. A person skilled in the art would have been motivated to look to the teachings in Basin-2005 to understand the wavelength emitted by the LED chip in Basin-2007 due to the structural similarity between the disclosed LEDs. (*Compare, e.g.,* EX1005, Fig. 2 *with* EX1006, Fig. 5.) And the information obtained from Basin-2005 is no more than the simple substitution of one known element for another to obtain predictable results. Thus, Basin-2007 in view of Basin-2005 renders obvious claim 1.

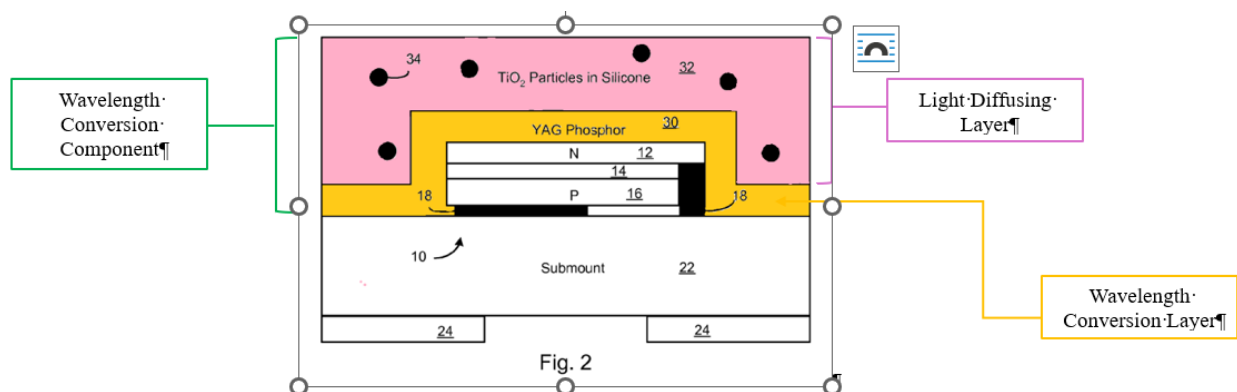
⁹ The graph in EX1012 has a linear x-axis while the graphs in EX1013, Stokes, and the '678 patent each have a logarithmic x-axis.

Independent Claim 1: Wavelength Conversion Component

[1pre] A wavelength conversion component for a light emitting device

The preamble is not limiting and is entitled to no patentable weight.

Nonetheless, Basin-2007 discloses a wavelength conversion component; namely, the combination of phosphor layer 30 and silicone encapsulant 32 as shown in the annotated image below. Basin-2007 discloses “a conventional white light LED [light source] encapsulated in silicone” including a blue-light LED chip. (EX1005, ¶[0021].) The blue-light LED chip is “covered by a layer of yttrium aluminum oxide garnet (YAG) phosphor that emits a yellow-green light when energized by the blue light.” (*Id.*, ¶[0003].) In reference to Fig. 2, Basin-2007 discloses “a phosphor layer 30 ... formed over the top of the LED for wavelength-converting the blue light emitted from the active layer 14” and “[a] silicone encapsulant 32 [] formed over the LED structure.” (*Id.*, ¶¶ [0027], [0029].)



Basin-2007, Annotated Figure 2

Accordingly, Basin-2007 discloses a light emitting device with a wavelength conversion component. (*See also* EX1002, ¶110.)

[1a] a wavelength conversion layer comprising particles of at least one photoluminescence material

Basin-2007 discloses the inclusion of a wavelength conversion layer comprising particles of at least one photoluminescence material. It is shown, for example, as layer 30 in the annotated Figure 2 above. Consistent with other white-light LED light sources, Basin-2007 discloses covering the blue-light LED with “a layer of yttrium aluminum oxide garnet (YAG) phosphor [a photoluminescent material] that emits a yellow-green light when energized by the blue light.” (*Id.*, ¶[0003]) “The phosphor layer 30 may be phosphor particles in a transparent or translucent binder, which may be organic or inorganic, or may be sintered phosphor particles.” (*Id.*, ¶[0027].) A POSA would understand that such “phosphor particles” are “photoluminescence materials” because they absorb blue light (high energy) and radiate light at a lower energy state. (*See* EX1002, ¶¶112-13.)

Accordingly, Basin-2007 discloses a wavelength conversion layer comprising particles of at least one photoluminescence material.

[1b] a light diffusing layer comprising particles of a light scattering material

Basin-2007 discloses a light diffusing layer comprising particles of a light scattering material shown, for example, as layer 32 in the annotated Figure 2 above. Basin-2007 discloses that “TiO₂ particles [34] are mixed with the encapsulant [32].” (*Id.*, ¶¶[0005, 0013, 0017, 0019, 0031, 0042].) Basin-2007 further discloses that “the TiO₂ particles scatter the light from the LED, which helps to mix the light output to create a more uniform brightness and color over the viewing field.” (*Id.*, ¶[0037].)

Accordingly, Basin-2007 discloses a light diffusing layer comprising particles of a light scattering material. (*See also* EX1002, ¶¶114-15.)

[1c] wherein the light diffusing layer improves an off-state white appearance of the wavelength conversion component

Basin-2007 discloses that the light diffusing layer improves an off-state white appearance of the wavelength conversion component. Indeed, the title of Basin-2007 is “LED with Particles in Encapsulant for Increased Light Extraction **and Non-Yellow Off-State Color**” (emphasis added). Basin-2007 discloses that “[i]f the LED has a yellowish YAG phosphor coating, the white [TiO₂] granules in the encapsulant make the LED appear whiter when the LED is in an off state, which is a more pleasing color when the LED is used as a white light flash in small cameras.” (*Id.*, Abstract.)

Basin-2007 discloses that “[t]he YAG phosphor coating on the LED appears yellow-green under white ambient light when the LED is off,” that “[s]uch a yellow-green color is generally not attractive” and that (“[i]t is desirable to somehow eliminate the yellow-green color of the [LED] flash in its off state.”) (*Id.*, ¶[0004].) The solution is straightforward: “Since the inert material (e.g., TiO₂, or ZrO₂) is white, the appearance of the LED with a YAG phosphor coating appears much whiter when the LED is off, which is more pleasing than the yellow-green color of the YAG phosphor.” (*Id.*, ¶[0010].)

Accordingly, Basin-2007 discloses the light diffusing layer improves an off-state white appearance of the wavelength conversion component. (*See also* EX1002, ¶¶116-18.)

[1d] wherein the wavelength conversion component is configured such that in operation a portion of excitation light comprising blue light having a wavelength of greater than or equal to 440 nm generated by the light emitting device is emitted through the wavelength conversion component to contribute to a final visible emission product

Basin-2007 discloses that a portion of excitation light comprising blue light having a wavelength of greater than or equal to 440 nm generated by the light emitting device is emitted through the wavelength conversion component to contribute to the final visible emission product.

For example, Basin-2007 discloses GaN-based LED light sources (*Id.*, ¶[0002]) in which “[t]he light emitted by the phosphor layer 30, when mixed with blue light, creates white light or another desired color. In the example, the phosphor is a yttrium aluminum oxide garnet (YAG) phosphor that produces yellow light (Y+B=white).” (*Id.*, [0027].) In other words, the blue light contributes to the final emission product.

A POSA would have understood the blue light disclosed in Basin-2007 to include blue light with a wavelength greater than 440 nm. The ’678 patent itself admits that blue-light LEDs were available off-the-shelf. (EX1002, ¶121.) Basin-2007 discloses that it is based on “a conventional white light LED” light source including an LED chip that “generates blue light.” (EX1005, ¶[0021-22].) In light of the state of the art, including as discussed in Shimizu above, a POSA would understand that the blue light LEDs used in conventional white-light LED light sources typically had wavelengths greater than 440 nm. (See EX1010, figs.; 23:43, 27:4-5, 28:55, 25:24-25, 29:45 (peaks at 450, 460, or 470nm); EX1006, ¶[0030] (“It is assumed the LEDs emit a blue light in the range of 420-490 nm.”); EX1008, 4:37-40 (420-480nm), 6:62-67 (peaks of 450nm or 480nm).) The ’678 patent shares this understanding, as is demonstrated by the addition of the “greater than or equal to 440 nm” requirement in order to distinguish blue light from UV light. (EX1004, pp.194, 200-03.)

Moreover, a white-light LED light source containing a blue-light LED chip generating “blue light having a wavelength of greater than or equal to 440 nm” would have been obvious in view of Basin-2005. (EX1002, ¶122.) Basin-2005 discloses a white-light LED light source containing a blue-light LED chip. Basin-2005 further discloses, for example, that “[i]t is assumed the LEDs emit a blue light in the range of 420-490 nm.” (EX1006, ¶[0030].)

A POSA would have been motivated to use a white-light LED light source disclosed by Basin-2005 as the “conventional white light LED” called for by Basin-2007. (EX1002, ¶123.) This is at least due to the structural similarity between the LEDs in Basin-2007 and Basin-2005. (*Compare, e.g.*, EX1005, Fig. 2 with EX1006, Fig. 5; EX1002, ¶123.) Having looked from Basin-2007 to Basin-2005, a POSA would have had a reasonable expectation of success, because Basin-2005 teaches that its white-light LED light source is “relatively easy to implement and consistently produces the desired white light temperature.” (EX1006, ¶[0006].)

Accordingly, Basin-2007 in combination with Basin-2005 discloses or suggests the wavelength conversion component is configured such that in operation a portion of excitation light comprising blue light having a wavelength of greater than or equal to 440 nm generated by the light emitting device is emitted through the wavelength conversion component to contribute to a final visible emission product. (*See also* EX1002, ¶¶119-24.)

Basin-2007 in view of Basin-2005 thus discloses all of the elements of claim 1 and renders claim 1 obvious. (See EX1002, ¶125.)

IX. [GROUND 2] Claims 11-14 are rendered obvious by Basin-2007 in view of Basin-2005 and Stokes

As discussed above, Ground 1 renders obvious independent claim 1 of the '678 patent. Ground 2 further includes the teaching from Stokes that selecting an appropriate particle size “enhances the scattering of the radiation source radiation while it decreases the amount of scattering of the luminescent material radiation” such that “the lamp radiation output is rendered more uniform because a greater amount of radiation source radiation is scattered toward the luminescent material[.]” (EX1008, 7:10-26.) As discussed above, the prior art discloses conventional white-light LED light sources with light diffusing layers as required by independent claim 1. Claims 11-14 further require the TiO₂ particles in the light diffusing layer be sized to preferentially scatter blue light relative to yellow light. Thus, Basin-2007 in view of Basin-2005 and Stokes renders obvious claims 11-14. (See also EX1022, ¶¶37-39.)

Claim 11: Scattering Relatively More Excitation Light

Claim 11 requires:

The component of claim 1, wherein the light scattering material has an average particle size that is selected such that the light scattering material will scatter the excitation

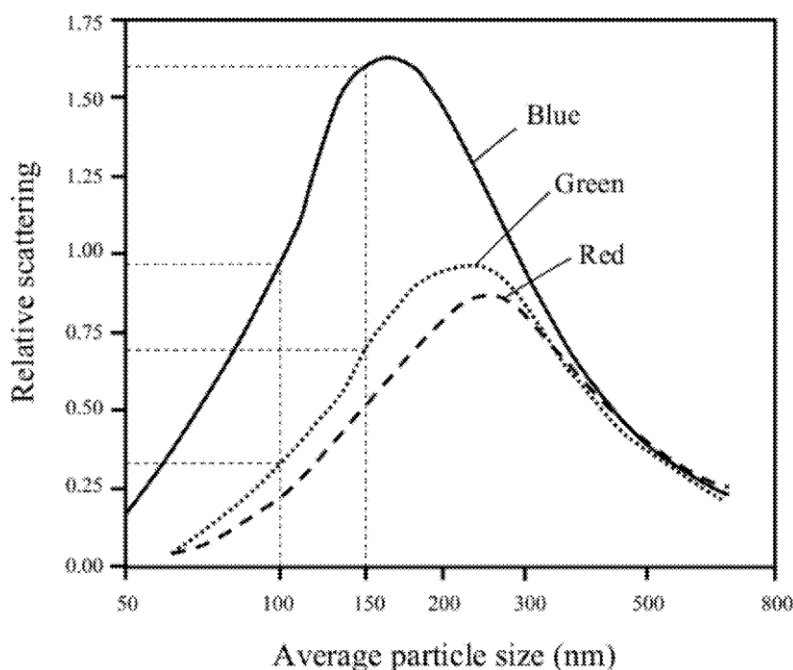
light relatively more than the light scattering material will scatter light generated by the at least one photoluminescence material.

Consistent with claim 11, Stokes discloses:

In one preferred embodiment, the radiation scattering particles have a size such that the particles preferentially scatter blue or UV LED light as compared to yellow, green, red or white light from the luminescent material.

(EX1008, 7:1-4.)

As discussed in detail above, Figure 10 of the '678 patent is essentially the same as graphs found in the prior art, including Figure 6 of Stokes, that were derived from the DuPont model described in the background (Section VII) above. In particular, the graphs purport to show the relative scattering power of TiO_2 based on particle size for different colors of light. (EX1022, ¶43.)



'678 Patent, Figure 10

Basin-2007 discloses a light scattering material with an average TiO_2 particle size that is “sub-micron” (less than 1000 nm). (EX1005, ¶[0005].) It further discloses that “[i]n one embodiment, the average TiO_2 particle size is 0.25 micron[(250 nm).]” (EX1005, ¶[0032].) According to the DuPont model, TiO_2 particles smaller than a micron generally scatter more blue light (e.g., excitation light) than red or green light (e.g., light emitted by the phosphor), including at 0.25 microns. (EX1022, ¶44.) Accordingly, Basin-2007 renders obvious claim 11 by literally disclosing the selection of average particle sizes that preferentially scatter blue light.

The basis on which a design decision is made is not a proper claim limitation, particularly for a system claim. Nonetheless, to the extent that the claim language “an average particle size that is selected such that [it preferentially scatters blue light]” requires an average particle size selected for that reason (rather than an average particle size that leads to that outcome), this claim element is rendered obvious by Stokes. (EX1022, ¶45.) As discussed above, Stokes explicitly discloses the selection of an average particle size “such that the particles preferentially scatter blue ... LED light as compared to yellow ... light from the luminescent material.” (EX1008, 7:1-4.)

As discussed in detail above, Ground 1 (Basin-2007 and Basin-2005) discloses white-light LED light sources with TiO₂-containing light diffusing layers, meeting every requirement of claim 11, including the claimed average particle size. To the extent that claim 11 is understood to also claim the basis for selecting a particular average particle size, a POSA would have had reason to use such a basis for selecting average particle size as taught by Stokes. (EX1022, ¶¶46-48.) For example, Stokes discloses:

[The relevant] particle size range is advantageous because it enhances the scattering of the radiation source radiation while it decreases the amount of scattering of the luminescent material radiation. Therefore, the lamp radiation output is rendered more uniform because a

greater amount of radiation source radiation is scattered toward the luminescent material, while a lesser amount of the luminescent material radiation that is emitted downward toward the radiation source is scattered back toward the luminescent material.

(EX1008, 7:17-26.)

Thus, a POSA would have been motivated to apply this principle to Basin-2007, because it would increase the conversion of blue light to yellow light and improve the uniformity of the light source. (EX1022, ¶48.) Conversion of blue light to yellow light is improved by maximizing the scattering of blue light. (*Id.*) Uniformity is improved by preferentially scattering the concentrated light from the blue-light LED chip instead of the disperse light emitted by the phosphor. (*Id.*)

A POSA would have had a reasonable expectation of success applying this principle to Basin-2007, because the relevant particle size range is encompassed the range disclosed by Basin-2007. A POSA would have recognized selecting an average particle size as a design decision to be made based on a number of factors, including the light scattering properties of the particles, and well within the skill of the art. (EX1022, ¶49.)

Thus, Ground 1 (Basin-2007 and Basin-2005) in further view of Stokes renders claim 11 obvious as a whole. (*See also* EX1022, ¶¶40-50.)

Claim 12: Scattering Excitation Light Twice as Much

Claim 12 requires “[t]he component of claim 11, wherein the light scattering material scatters the excitation light at least twice as much as light generated by the at least one photoluminescence material.”

As discussed above, Basin-2007 in view of Basin-2005 and Stokes renders obvious claim 11. Claim 12 only further requires that the “relatively more” of claim 11 be “at least twice as much.” The ’678 patent discloses no particular significance to “at least twice as much” which represents a straightforward narrowing of the claimed average particle size range from claim 11 so that it extends only up to around 175 nm, with the ’678 patent disclosing a preferred range of 0.10 to 0.15 microns (100 nm to 150 nm). (EX1001, 11:65-12:2; *see also* EX1022, ¶¶51-52.)

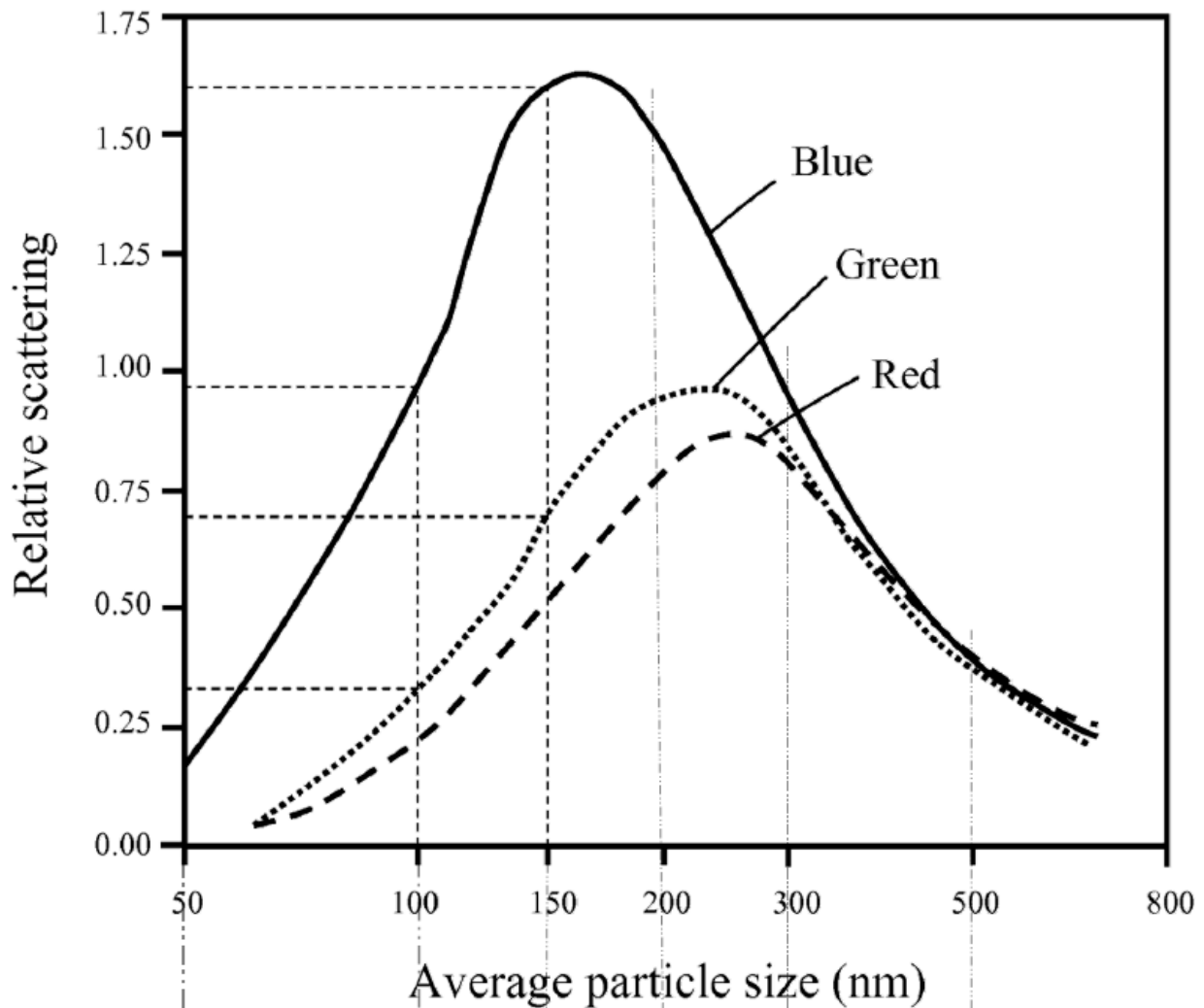
As the Federal Circuit has explained:

“A *prima facie* case of obviousness typically exists when the ranges of a claimed composition overlap the ranges disclosed in the prior art.” *In re Peterson*, 315 F.3d 1325, 1329 (Fed. Cir. 2003) (citing *In re Geisler*, 116 F.3d 1465, 1469 (Fed. Cir. 1997)); *see also E.I. du Pont de Nemours & Co. v. Synvina C.V.*, 904 F.3d 996, 1006 (Fed. Cir. 2018); *Iron Grip Barbell Co. v. USA Sports, Inc.*, 392 F.3d 1317, 1322 (Fed. Cir. 2004). “The point of [the Federal Circuit’s] overlapping range cases is that, in the absence

of evidence indicating that there is something special or critical about the claimed range, an overlap suffices to show that the claimed range was disclosed in—and therefore obvious in light of—the prior art.” *E.I. du Pont*, 904 F.3d at 1008. A presumption of obviousness does not shift the burden of persuasion to the patentee to prove nonobviousness, but a presumption establishes that, “absent a reason to conclude otherwise, a factfinder is justified in concluding that a disclosed range does just that—discloses the entire range.” *Id.*

Almirall, LLC v. Amneal Pharms. LLC, 28 F.4th 265, 273 (Fed. Cir. 2022).

Accordingly, claim 12 is *prima facie* obvious for the same reasons that claim 11 is obvious. The annotated Figure 10 shown on the next page compares the ranges claimed in the ’678 patent to the ranges disclosed by Stokes. (EX1022, ¶54.)



Stokes, 7:4-17 – “preferentially scatter” blue light

Stokes, *id.* – “scatter at least 50% more” (up to ≈ 225 nm)

Stokes, *id.* – “100 to 200 nm” (exemplary range)

’678 patent, claims 11 and 13 – scatter “relatively more” blue light than red/green

’678 patent, claim 12 – “scatter at least twice as much” (up to ≈ 175 nm, *see* 12:5-8)

’678 patent, claim 14 – “less than 150 nm”

’678 patent, 11:65-12:2 – “100 to 150 nm” (exemplary range)

Annotated Figure 10

Moreover, consistent with claim 12, Stokes discloses the routine optimization of average particle size¹⁰ to preferentially scatter blue light. (EX1022, ¶55.) In particular, as reflected in the annotated Figure 10 of the '678 patent above, Stokes explicitly discloses selecting an average particle size that scatters excitation light at least 1.5 times as much as light emitted by the phosphor and gives an exemplary range of 0.10 to 0.20 microns (100 to 200nm). That is:

Preferably, the particle size is selected such that the particles scatter **at least 50% more** radiation source radiation than luminescent material radiation. FIG. 6 illustrates the relationship between the particle diameter and the wavelength of the scattered light for Ti-Pure® rutile TiO₂ particles made by DuPont. As illustrated in FIG. 6, the relative scattering power of 100 to 200 nm TiO₂ particles is above 1 for blue incident radiation, while it is

¹⁰ Consistent with the DuPont model being theoretical, the DuPont graphs and related prior art such as Stokes are based on exact particle size, not the more practical average particle size. A broad distribution of particle sizes may have the same average particle size as a narrower distribution while having very different scattering properties. Given that the average particle size of a set of exact theoretical particles is the same as the exact particle size, the distinction does not matter here. (EX1022, ¶55 n.6.)

below 1 for green and red incident radiation. Therefore, as illustrated in FIG. 6, **100 to 200 nm particles have at least a 50% greater scattering power** for blue radiation (i.e., such as that emitted by a blue emitting LED) than green or red (or for that matter yellow) radiation (i.e., such as that emitted by the phosphor or dye).

(EX1008, 7:4-17; *see also* EX1024 (Toquin) at ¶¶[0080]-[0081] (disclosing preferentially scattering blue light using particles of approximately 150 nm).)

The set of particle sizes that scatter blue light at least 1.5 times as much as red/green light necessarily includes all the particle sizes that scatter blue light at least 2 times as much as red/green light. (See EX1022, ¶57.) Thus, as illustrated in the annotated Figure 10 above, the range of average particle size disclosed by Stokes based on preferentially scattering blue light overlaps and entirely encompasses the similar range required by claim 12, rendering claim 12 obvious. (*Id.*)

Neither Stokes nor the '678 patent assign any particular significance to the disclosed ranges, other than that they are based on preferentially scattering blue light. (EX1022, ¶58.) The values recited for the endpoints of both ranges appear to be based on rough estimations in reading DuPont's chart. (*Id.*) And the difference between the disclosed ranges is one of degree rather than kind. (*Id.*) As discussed above, a POSA would have recognized selecting an average particle size as a

design decision to be made based on a number of factors, including the light scattering properties of the particles, and well within the skill of the art. For example, a POSA would weigh the benefits of maximizing the ratio of blue light scattered compared to yellow light with the potential downsides, including not maximizing blue light scattered, decreasing light output due to increased internal reflection, and limiting the commercially-practical options for rutile TiO₂ by requiring a narrower range of average particle size. (*Id.*)

Thus, Ground 1 (Basin-2007 and Basin-2005) in further view of Stokes renders claim 12 obvious as a whole. (*See also* EX1022, ¶¶51-60.)

Claim 13: Excitation Light is Blue Light

Claim 13 requires “[t]he component of claim 11, wherein the excitation light comprises blue light.”

As discussed above, Basin-2007 in view of Basin-2005 and Stokes renders obvious claim 11. And independent claim 1 already requires “excitation light comprising blue light.” As discussed in detail above with respect to claim element 1d, Basin-2007 in view of Basin-2005 discloses excitation light comprising blue light. (*See, e.g.*, EX1005, ¶[0021-22]; EX1006, ¶[0030].)

Thus, Ground 1 (Basin-2007 and Basin-2005) in further view of Stokes renders claim 13 obvious as a whole. (*See also* EX1022, ¶¶61-64.)

Claim 14: Average Particle Size Less Than 150 nm

Claim 14 requires “[t]he component of claim 13, wherein the light scattering material has an average particle size that is less than about 150 nm.”

As discussed above, Basin-2007 in view of Basin-2005 and Stokes renders obvious claim 13. Claim 14 claims a range of average particle sizes with the lower bound of claim 11 (“relatively more”) and the upper bound of the exemplary range disclosed by the ’678 patent (150 nm), as illustrated in the annotated Figure 10 above. The ’678 patent discloses no particular significance to any of these ranges. (EX1022, ¶¶65-67.) With respect to the 150 nm bound, the ’678 patent simply states:

Light diffractive particles within the light diffusing layer are selected to have a size such that the particles will scatter blue light generated by the LED relatively more than they will scatter light generated by a wavelength conversion layer, e.g., where the particles have an average particle size that is less than about 150 nm.

(EX1001, 25:53-58.)

As discussed in detail above, consistent with claim 14, Stokes discloses the routine optimization of average particle size to preferentially scatter blue light and discloses a preferred range of about 100 to 200 nm. (*See, e.g.*, EX1008, 7:4-17; EX1022, ¶69.) Thus, as shown in the annotated Figure 10 above, Stokes discloses

ranges of average particle size that encompass and overlap the claimed range of average particle sizes—including the 100 to 150 nm range that is described as advantageous (EX1001, 8:53-54) and essentially the same as the range required by claim 12—rendering claim 14 obvious. (EX1022, ¶70.) As discussed above, these ranges have no particular significance, other than that they are based on preferentially scattering blue light. (EX1022, ¶71.) As also discussed above, a POSA would have recognized selecting an average particle size as a design decision to be made based on a number of factors, including the light scattering properties of the particles, and well within the skill of the art. (*Id.*)

Thus, Ground 1 (Basin-2007 and Basin-2005) in further view of Stokes renders claim 14 obvious as a whole. (*See also* EX1022, ¶¶65-72.)

X. [GROUND 3] Claims 1 and 11-14 are rendered obvious by Krummacher in view of Shimizu and Stokes

Like Basin-2007, Krummacher discloses every element in the challenged claims except the specific wavelength of the blue light emitted by the LED chip. But LED chips emitting blue light at greater than or equal to 440 nm were well known in the art as evidenced by Shimizu and Stokes (which incorporates Shimizu). Thus, Krummacher in view of Shimizu and Stokes renders obvious claim 1.

Claims 11-14 further require the TiO₂ particles in the light diffusing layer be sized to preferentially scatter blue light relative to yellow light. Similar to Ground 2, Ground 3 applies the teaching from Stokes that selecting an appropriate particle size “enhances the scattering of the radiation source radiation while it decreases the amount of scattering of the luminescent material radiation” such that “the lamp radiation output is rendered more uniform because a greater amount of radiation source radiation is scattered toward the luminescent material[.]” EX1008, 7:10-26.) Thus, Krummacher in view of Shimizu and Stokes also renders obvious claims 11-14. (See also EX1022, ¶¶73-75.)

FIG 1

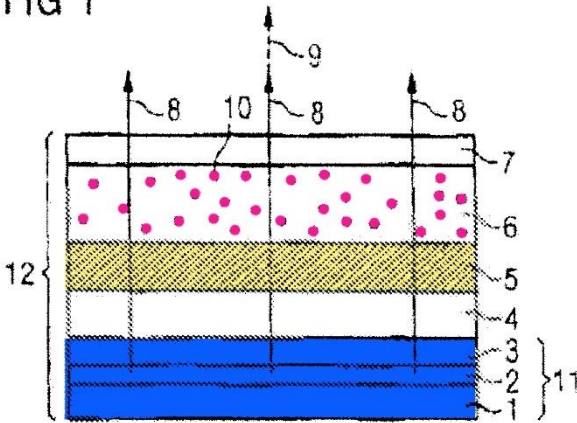
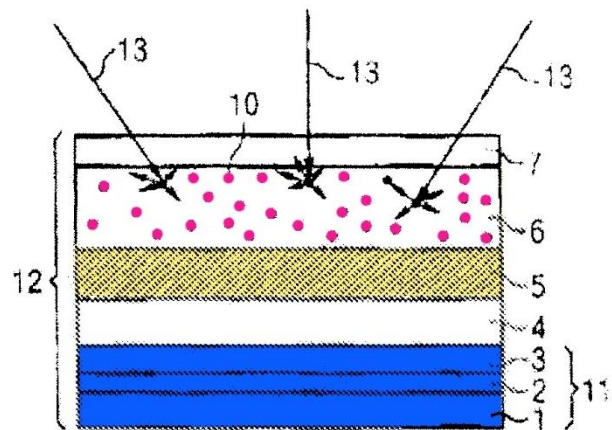


FIG 2



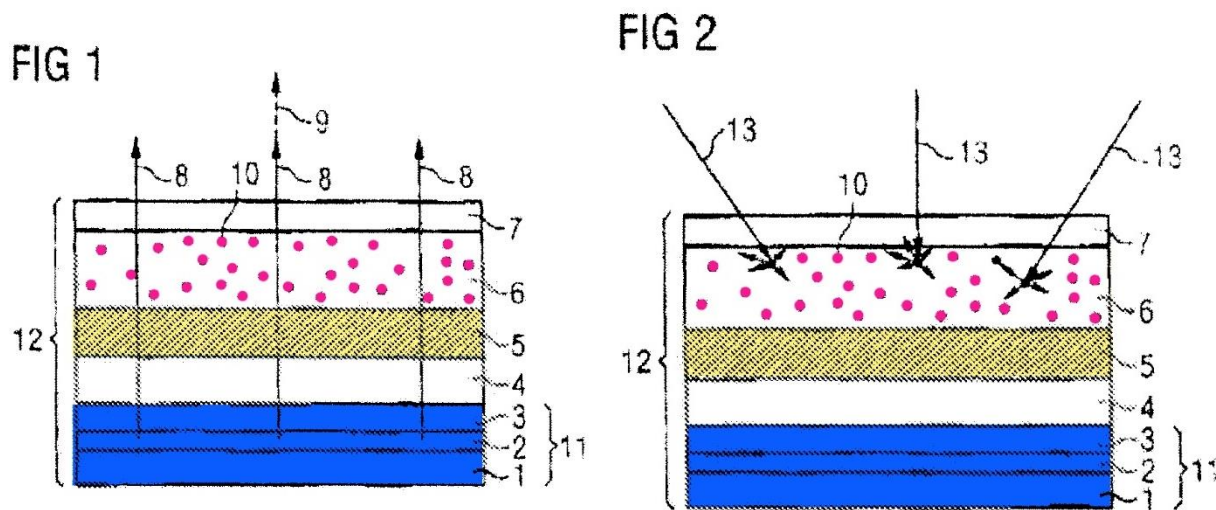
Krummacher, Annotated Figures 1-2

Independent Claim 1: Wavelength Conversion Component

[1pre] A wavelength conversion component for a light emitting device

The preamble is not limiting and is entitled to no patentable weight.

Nonetheless, Krummacher discloses a wavelength conversion component. As shown in the annotated images below, Krummacher discloses in Figures 1 and 2 an “optoelectronic component” that includes a layer sequence 11, a luminescence conversion layer 5, and light-scattering translucent layer 6.” (EX1007, ¶¶[0034], [0038].)



Krummacher, Annotated Figures 1-2

The combination of the luminescence conversion layer and the light-scattering translucent layer comprise the wavelength conversion component. (See also EX1002, ¶¶197-201.)

[1a] a wavelength conversion layer comprising particles of at least one photoluminescence material

Krummacher discloses a wavelength conversion layer comprising particles of at least one photoluminescence material. It is shown, for example, as layer 5 in the annotated Figures 1 and 2 above, highlighted in yellow.

Krummacher discloses that “[t]he luminescence conversion material of the luminescence conversion layer 5 is advantageously embedded in a transparent matrix, for example in polycarbonate, silicone, epoxy or PMMA.” (EX1007, ¶[0037]; *see also id.*, ¶[0023].) Krummacher describes the operation of the layer as follows:

At least a portion of the radiation emitted by the active layer 2 is converted by the luminescence conversion layer 5 to a longer wavelength. In particular, ultraviolet or blue radiation emitted by active layer 2 can be converted to radiation having a longer wavelength, particularly of a complementary color, such as yellow, for example, to produce white light. Luminescence conversion materials suitable for this purpose are known, for example, from the document WO97/50132, whose disclosure content in this regard is hereby incorporated by reference. Particularly suitable are cerium-doped garnets, such as YAG:Ce, for example.

(EX1007, ¶[0036].) A POSA would understand YAG:Ce to be present as particles in the wavelength conversion layer for embedding in silicone or epoxy (EX1007, ¶[0037]), as taught by Shimizu and Stokes, and that such particles are “photoluminescence materials” because they absorb blue light (high energy) and radiate light at a lower energy state. (EX1002, ¶86.)

Accordingly, Krummacher discloses a wavelength conversion layer comprising particles of at least one photoluminescence material. (*See also* EX1002, ¶¶202-04.)

[1b] a light diffusing layer comprising particles of a light scattering material

Krummacher discloses the inclusion of a light diffusing layer comprising particles of a light scattering material. It is shown, for example, as layer 6 in the annotated Figures 1 and 2 above.

In particular, Krummacher discloses that:

The luminescence conversion layer 5 is followed in the radiation direction 9 by a light-scattering translucent layer 6. Said light-scattering translucent layer 6 is advantageously at least partially transparent to the radiation 8 emitted by active layer 2 and at least partially converted by luminescence conversion layer 5.

(EX1007, ¶[0038].) Krummacher further discloses the light diffusing layer containing TiO₂ particles. (EX1007, ¶[[0039].)

Accordingly, Krummacher discloses a light diffusing layer comprising particles of a light scattering material. (*See also* EX1002, ¶¶205-07.)

[1c] wherein the light diffusing layer improves an off-state white appearance of the wavelength conversion component

Krummacher discloses that the light diffusing layer improves an off-state white appearance of the wavelength conversion component.

Krummacher discloses that in conventional optoelectronic components:

[T]he optical impression produced by the optoelectronic component when it is in the off state frequently is not satisfactory. The reason for this is that in a bright environment, the luminescence conversion layer is stimulated to emit yellow light even when the optoelectronic component is off, but without the superimposition of blue light to yield white light, as when it is on. As a result, in the off state, the surface of the optoelectronic component in the areas provided with the luminescence conversion layer exhibit the color of the longer wavelength produced by luminescence conversion—yellow, for example—which is often found unattractive by observers.

(EX1007, ¶[0004].)

Krummacher solves this problem, explaining that:

Advantageously, the distribution, size and material of the light-scattering particles 10 in light-scattering translucent layer 6 are selected such that the surface of light scattering translucent layer 6 appears white. In this way, the luminescence conversion layer 5 is advantageously

prevented from exhibiting a yellowish hue, in the off state of the optoelectronic component depicted in FIG. 2, due to stimulation of the luminescence conversion materials by environmental light 13 incident from the outside.

(EX1007, ¶[0041].)

Accordingly, Krummacher discloses the light diffusing layer improves an off-state white appearance of the wavelength conversion component. (*See also* EX1002, ¶¶208-10.)

[1d] wherein the wavelength conversion component is configured such that in operation a portion of excitation light comprising blue light having a wavelength of greater than or equal to 440 nm generated by the light emitting device is emitted through the wavelength conversion component to contribute to a final visible emission product

Krummacher discloses that a portion of excitation light comprising blue light having a wavelength of greater than or equal to 440 nm generated by the light emitting device is emitted through the wavelength conversion component to contribute to the final visible emission product.

For example, Krummacher discloses that:

Known from the document WO 97/50132 is a radiation-emitting optoelectronic component in which at least a portion of the radiation emitted by an active layer of said optoelectronic component is converted to larger wavelengths by means of a luminescence conversion layer. In this way, for example a radiation-emitting active

region that emits blue or ultraviolet light can be used to generate mixed-color or white light. As a rule, blue or ultraviolet light is converted by such a luminescence conversion layer to light of a longer wavelength, particularly to light of a complementary color, such as yellow, for example, such that the blue or ultraviolet radiation emitted by the active region is superimposed on the fraction converted to the complementary color to yield white light

(EX1007, ¶[0003].)

Although Krummacher does not specify the wavelength of blue light emitted by its LED chip, a POSA would have understood it to include blue light with a wavelength greater than 440 nm. (EX1002, ¶211-13.) In addition to being a white-light emitting LED device, Krummacher discloses that “the optoelectronic component is for example an LED or an LED module comprising one or more radiation-emitting semiconductor chips, in which case said semiconductor chip or chips emit blue or ultraviolet light that is converted to white light by the luminescence conversion layer.” (EX1007, ¶[0022].) Krummacher discloses that “active layer 2 is preferably an organic light-emitting layer, particularly emitting blue light” or “an inorganic semiconductor material, preferably emitting in the blue and/or ultraviolet region of the spectrum.” (*Id.*, ¶¶[0031]-[0032].) “The active layer

2 can in particular comprise a nitride compound semiconductor material, for example $\text{In}_x\text{Al}_y\text{Ga}_{1-x-y}$ where $0 \leq x \leq 1$ and $x+y \leq 1$.” (*Id.*, ¶[0032].)

Moreover, a white-light LED light source containing a blue-light LED chip generating “blue light having a wavelength of greater than or equal to 440 nm” would have been obvious in view of Shimizu and Stokes, which incorporates Shimizu. (EX1002, ¶214.) Stokes and Shimizu both disclose white-light LED light sources with blue-light LED chips. As discussed above with respect to the state of the art, Shimizu provides wavelength charts for multiple blue-light LED chips, all of which show emission light including wavelengths above 440 nm. (EX1010 at Figs.) Shimizu further discloses a dozen examples with blue-light LED chips having emission peaks at 450 nm (23:43, 27:4-5, 28:55), 460 nm (25:24-25), or 470 nm (29:45), but none at shorter wavelengths. And Stokes discloses an LED chip that “emits blue light 48 having a wavelength between about 420 and 480 nm” (EX1008 at 4:37-40) along with “blue emitting LEDs having a peak emission wavelength of $\lambda=450$ nm” or “peak emission wavelength of $\lambda=480$ nm” (*Id.*, at 6:62-67).

A POSA would have been motivated to use a blue-light LED chip like that disclosed by Stokes and Shimizu in a conventional white-light LED light source called for by Krummacher. (EX1002, ¶215.) Shimizu, in particular, is cited by both the ’678 patent and the prior art as an example of a conventional white-light LED

light source containing a blue-light LED. Thus, it would have been obvious to look to Shimizu and Stokes for details of the conventional white-light LED light source used in Krummacher, and a POSA would have had a reasonable expectation of success in doing so, because they would simply be using the conventional white light LED disclosed in the prior art as directed by Krummacher. In other words, not only does Krummacher suggest the use of an LED like that disclosed in Stokes and Shimizu, doing so would have been the simple substitution of one known element for another to obtain predictable results and well within the skill of a POSA. (EX1002, ¶¶216-17.)

Accordingly, Krummacher in view of Shimizu and Stokes discloses or suggests all elements in this limitation.

Krummacher in view of Shimizu and Stokes thus renders claim 1 obvious as a whole.

Claim 11: Scattering Relatively More Excitation Light

Claim 11 requires:

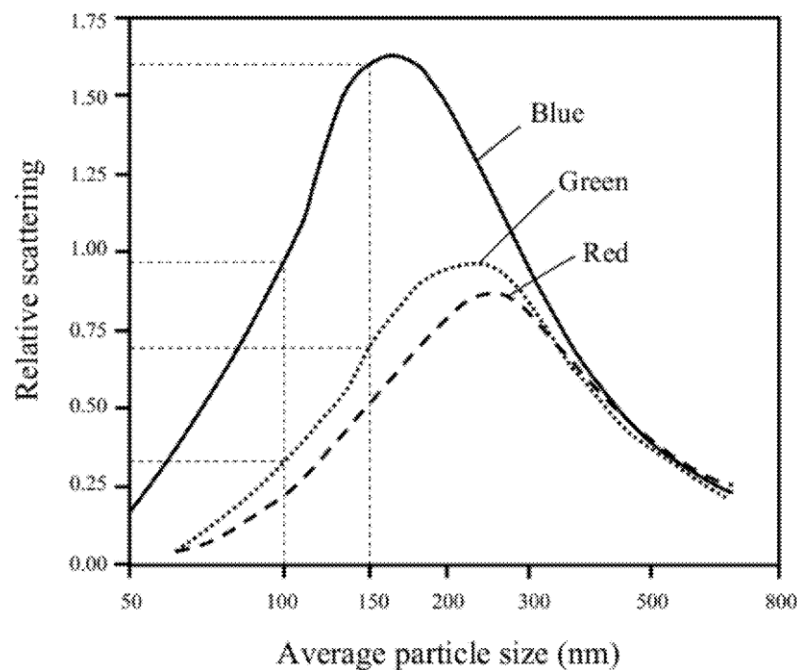
The component of claim 1, wherein the light scattering material has an average particle size that is selected such that the light scattering material will scatter the excitation light relatively more than the light scattering material will scatter light generated by the at least one photoluminescence material.

Consistent with claim 11, Stokes discloses:

In one preferred embodiment, the radiation scattering particles have a size such that the particles preferentially scatter blue or UV LED light as compared to yellow, green, red or white light from the luminescent material.

(EX1008, 7:1-4.)

As discussed in detail above, Figure 10 of the '678 patent is essentially the same as graphs found in the prior art, including Figure 6 of Stokes, that were derived from the DuPont model described in the background (Section VII) above. In particular, the graphs purport to show the relative scattering power of TiO_2 based on particle size for different colors of light. (EX1022, ¶79.)



'678 Patent, Figure 10

Krummacher discloses a light scattering material with TiO_2 particles “preferably having a radius of between 50 nm inclusive and 1000 nm inclusive.” (EX1007, ¶[0039].) According to the DuPont model, TiO_2 particles of such a size generally scatter more blue light (e.g., excitation light) than red or green light (e.g., light emitted by the phosphor). (EX1022, ¶80.) Accordingly, Krummacher renders obvious claim 11 by literally disclosing the selection of average particle sizes that preferentially scatter blue light.

The basis on which a design decision is made is not a proper claim limitation, particularly for a system claim. Nonetheless, to the extent that the claim language “an average particle size that is selected such that [it preferentially

scatters blue light]” requires an average particle size selected for that reason (rather than an average particle size that leads to that outcome), this claim element is rendered obvious by Stokes. (EX1022, ¶81.) As discussed above, Stokes explicitly discloses the selection of an average particle size “such that the particles preferentially scatter blue ... LED light as compared to yellow ... light from the luminescent material.” (EX1008, 7:1-4.)

As discussed in detail above, Krummacher in view of Shimizu and Stokes discloses white-light LED light sources with TiO₂-containing light diffusing layers, meeting every requirement of claim 11, including the claimed average particle size. To the extent that claim 11 is understood to also claim the basis for selecting a particular average particle size, a POSA would have had reason to use such a basis for selecting average particle size as taught by Stokes. (EX1022, ¶¶82-84.) For example, Stokes discloses:

[The relevant] particle size range is advantageous because it enhances the scattering of the radiation source radiation while it decreases the amount of scattering of the luminescent material radiation. Therefore, the lamp radiation output is rendered more uniform because a greater amount of radiation source radiation is scattered toward the luminescent material, while a lesser amount of the luminescent material radiation that is emitted

downward toward the radiation source is scattered back
toward the luminescent material.

(EX1008, 7:17-26.)

Thus, a POSA would have been motivated to apply this principle to Krummacher, because it would increase the conversion of blue light to yellow light and improve the uniformity of the light source. (EX1022, ¶84.) Conversion of blue light to yellow light is improved by maximizing the scattering of blue light. (*Id.*) Uniformity is improved by preferentially scattering the concentrated light from the blue-light LED chip instead of the disperse light emitted by the phosphor. (*Id.*)

A POSA would have had a reasonable expectation of success applying this principle to Krummacher, because the relevant particle size range includes the range disclosed by Krummacher. A POSA would have recognized selecting an average particle size as a design decision to be made based on a number of factors, including the light scattering properties of the particles, and well within the skill of the art. (EX1022, ¶85.)

Thus, Krummacher in view of Shimizu and Stokes renders claim 11 obvious as a whole. (*See also* EX1022, ¶¶76-86.)

Claim 12: Scattering Excitation Light Twice As Much

Claim 12 requires “[t]he component of claim 11, wherein the light scattering material scatters the excitation light at least twice as much as light generated by the at least one photoluminescence material.”

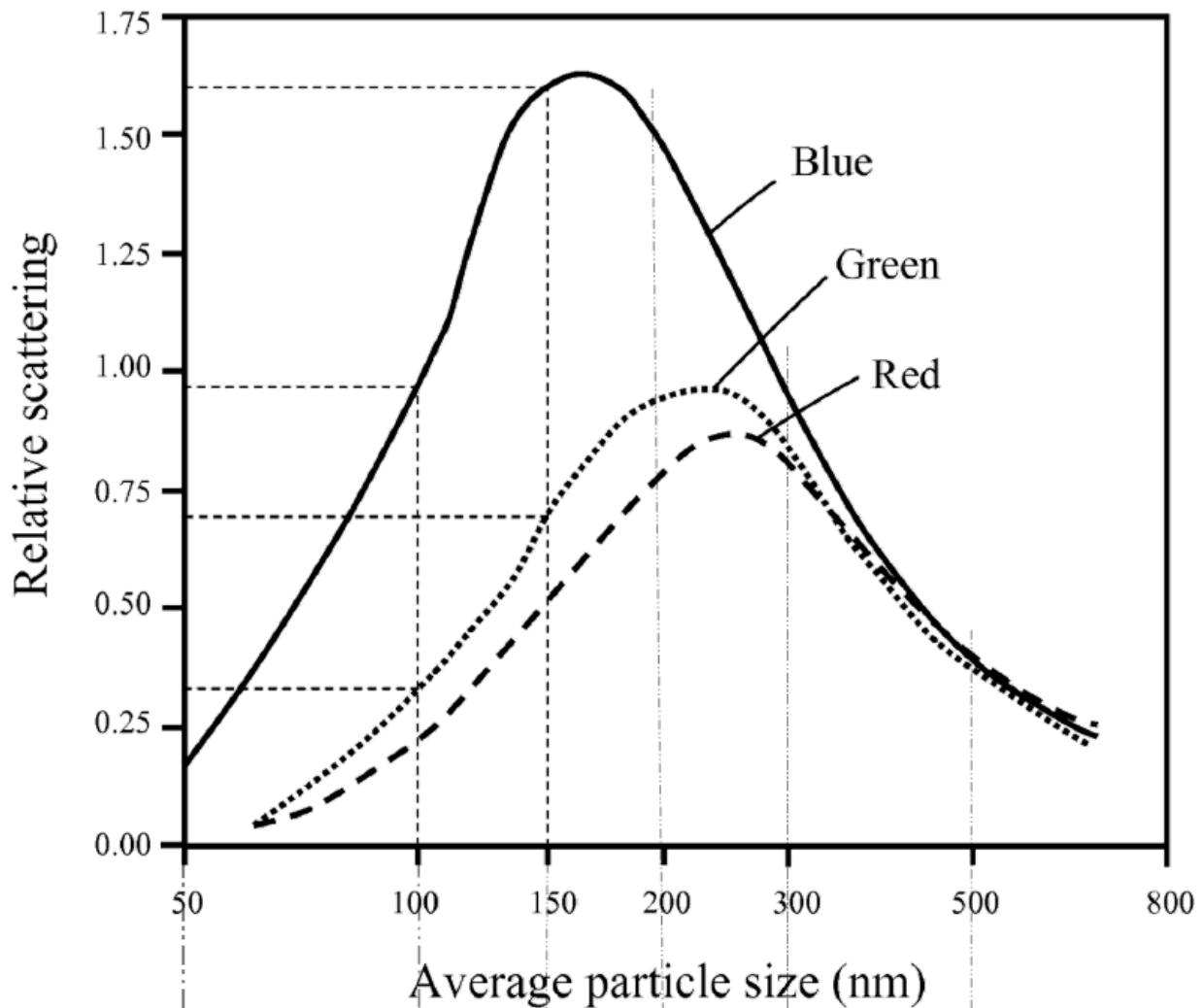
As discussed above, Krummacher in view of Shimizu and Stokes renders obvious claim 11. Claim 12 only further requires that the “relatively more” of claim 11 be “at least twice as much.” The ’678 patent discloses no particular significance to “at least twice as much” which represents a straightforward narrowing of the claimed average particle size range from claim 11 so that it extends only up to around 175 nm, with the ’678 patent disclosing a preferred range of 0.10 to 0.15 microns (100 nm to 150 nm). (EX1001, 11:65-12:2; see also EX1022, ¶¶87-88.) As the Federal Circuit has explained:

“A *prima facie* case of obviousness typically exists when the ranges of a claimed composition overlap the ranges disclosed in the prior art.” *In re Peterson*, 315 F.3d 1325, 1329 (Fed. Cir. 2003) (citing *In re Geisler*, 116 F.3d 1465, 1469 (Fed. Cir. 1997)); see also *E.I. du Pont de Nemours & Co. v. Synvina C.V.*, 904 F.3d 996, 1006 (Fed. Cir. 2018); *Iron Grip Barbell Co. v. USA Sports, Inc.*, 392 F.3d 1317, 1322 (Fed. Cir. 2004). “The point of [the Federal Circuit’s] overlapping range cases is that, in the absence of evidence indicating that there is something special or

critical about the claimed range, an overlap suffices to show that the claimed range was disclosed in—and therefore obvious in light of—the prior art.” *E.I. du Pont*, 904 F.3d at 1008. A presumption of obviousness does not shift the burden of persuasion to the patentee to prove nonobviousness, but a presumption establishes that, “absent a reason to conclude otherwise, a factfinder is justified in concluding that a disclosed range does just that—discloses the entire range.” *Id.*

Almirall, LLC v. Amneal Pharms. LLC, 28 F.4th 265, 273 (Fed. Cir. 2022).

Accordingly, claim 12 is *prima facie* obvious for the same reasons that claim 11 is obvious. The annotated Figure 10 shown on the next page compares the ranges claimed in the ’678 patent to the ranges disclosed by Stokes. (EX1022, ¶90.)



Stokes, 7:4-17 – “preferentially scatter” blue light

Stokes, *id.* – “scatter at least 50% more” (up to ≈ 225 nm)

Stokes, *id.* – “100 to 200 nm” (exemplary range)

’678 patent, claims 11 and 13 – scatter “relatively more” blue light than red/green

’678 patent, claim 12 – “scatter at least twice as much” (up to ≈ 175 nm, *see* 12:5-8)

’678 patent, claim 14 – “less than 150 nm”

’678 patent, 11:65-12:2 – “100 to 150 nm” (exemplary range)

Annotated Figure 10

Moreover, consistent with claim 12, Stokes discloses the routine optimization of average particle size¹¹ to preferentially scatter blue light. (EX1022, ¶91.) In particular, as reflected in the annotated Figure 10 of the '678 patent above, Stokes explicitly discloses selecting an average particle size that scatters excitation light at least 1.5 times as much as light emitted by the phosphor and gives an exemplary range of 0.10 to 0.20 microns (100 to 200nm). That is:

Preferably, the particle size is selected such that the particles scatter **at least 50% more** radiation source radiation than luminescent material radiation. FIG. 6 illustrates the relationship between the particle diameter and the wavelength of the scattered light for Ti-Pure® rutile TiO₂ particles made by DuPont. As illustrated in FIG. 6, the relative scattering power of 100 to 200 nm TiO₂ particles is above 1 for blue incident radiation, while it is

¹¹ Consistent with the DuPont model being theoretical, the DuPont graphs and related prior art such as Stokes are based on exact particle size, not the more practical average particle size. A broad distribution of particle sizes may have the same average particle size as a narrower distribution while having very different scattering properties. Given that the average particle size of a set of exact theoretical particles is the same as the exact particle size, the distinction does not matter here. (EX1022, ¶91 n.7.)

below 1 for green and red incident radiation. Therefore, as illustrated in FIG. 6, **100 to 200 nm particles have at least a 50% greater scattering power** for blue radiation (i.e., such as that emitted by a blue emitting LED) than green or red (or for that matter yellow) radiation (i.e., such as that emitted by the phosphor or dye).

(EX1008, 7:4-17; *see also* EX1024 (Toquin) at ¶¶[0080]-[0081] (disclosing preferentially scattering blue light using particles of approximately 150 nm).)

The set of particle sizes that scatter blue light at least 1.5 times as much as red/green light necessarily includes all the particle sizes that scatter blue light at least 2 times as much as red/green light. (*See* EX1022, ¶93.) Thus, as illustrated in the annotated Figure 10 above, the range of average particle size disclosed by Stokes based on preferentially scattering blue light overlaps and entirely encompasses the similar range required by claim 12, rendering claim 12 obvious. (*Id.*)

Neither Stokes nor the '678 patent assign any particular significance to the disclosed ranges, other than that they are based on preferentially scattering blue light. (EX1022, ¶94.) The values recited for the endpoints of both ranges appear to be based on rough estimations in reading DuPont's chart. (*Id.*) And the difference between the disclosed ranges is one of degree rather than kind. (*Id.*) As discussed above, a POSA would have recognized selecting an average particle size as a

design decision to be made based on a number of factors, including the light scattering properties of the particles, and well within the skill of the art. For example, a POSA would weigh the benefits of maximizing the ratio of blue light scattered compared to yellow light with the potential downsides, including not maximizing blue light scattered, decreasing light output due to increased internal reflection, and limiting the commercially-practical options for rutile TiO₂ by requiring a narrower range of average particle size. (*Id.*)

Thus, Krummacher in view of Shimizu and Stokes renders claim 12 obvious as a whole. (*See also* EX1022, ¶¶87-96.)

Claim 13: Excitation Light is Blue Light

Claim 13 requires “[t]he component of claim 11, wherein the excitation light comprises blue light.”

As discussed above, Krummacher in view of Shimizu and Stokes renders obvious claim 11. And independent claim 1 already requires “excitation light comprising blue light.” As discussed in detail above with respect to claim element 1d, Krummacher in view of Shimizu and Stokes discloses excitation light comprising blue light. (*See, e.g.*, EX1005, ¶[0021-22]; EX1006, ¶[0030].)

Thus, Krummacher in view of Shimizu and Stokes renders claim 13 obvious as a whole. (*See also* EX1022, ¶¶97-100.)

Claim 14: Average Particle Size Less Than 150 nm

Claim 14 requires “[t]he component of claim 13, wherein the light scattering material has an average particle size that is less than about 150 nm.”

As discussed above, Krummacher in view of Shimizu and Stokes renders obvious claim 13. Claim 14 claims a range of average particle sizes with the lower bound of claim 11 (“relatively more”) and the upper bound of the exemplary range disclosed by the ’678 patent (150 nm). The ’678 patent discloses no particular significance to any of these ranges. (EX1022, ¶¶101-103.) With respect to the 150 nm bound, the ’678 patent simply states:

Light diffractive particles within the light diffusing layer are selected to have a size such that the particles will scatter blue light generated by the LED relatively more than they will scatter light generated by a wavelength conversion layer, e.g., where the particles have an average particle size that is less than about 150 nm.

(EX1001, 25:53-58.)

As discussed in detail above, consistent with claim 14, Stokes discloses the routine optimization of average particle size to preferentially scatter blue light and discloses a preferred range of about 100 to 200 nm. (See, e.g., EX1008, 7:4-17; EX1022, ¶105.) Thus, as shown in the annotated Figure 10 above, Stokes discloses ranges of average particle size that encompass and overlap the claimed range of

average particle sizes—including the 100 to 150 nm range that is described as advantageous (EX1001, 8:53-54) and essentially the same as the range required by claim 12—rendering claim 14 obvious. (EX1022, ¶106.) As discussed above, these ranges have no particular significance, other than that they are based on preferentially scattering blue light. (EX1022, ¶107.) As also discussed above, a POSA would have recognized selecting an average particle size as a design decision to be made based on a number of factors, including the light scattering properties of the particles, and well within the skill of the art. (*Id.*)

Thus, Krummacher in view of Shimizu and Stokes renders claim 14 obvious as a whole. (*See also* EX1022, ¶¶101-108.)

XI. MATERIAL DIFFERENCES FROM PROSECUTION SUPPORT INSTITUTION (35 U.S.C. § 325(d))

None of Basin-2007, Basin-2005, Krummacher or Stokes were before the Examiner during prosecution and are not similar to any art considered during prosecution. Indeed, the Examiner was not made aware of any of the numerous prior art references disclosing the use of a light diffusing layer with a white-light LED light source despite one such reference being discussed in the Background of the '678 patent.

The applicants did not inform the Examiner that Shimizu disclosed using a molding containing TiO₂ to obscure the yellow phosphor.

Nor did the applicants inform the Examiner that at least Figure 10 of the '678 patent was based on information obtained from DuPont and well-known in the prior art.

Each of these disclosures refute the notion that it would not have been obvious to use a light diffusing layer with a white-light LED light source, which was the reason for allowance identified by the Examiner.

Because there are material differences between the art presented here and that applied during prosecution, and because challenged claims issued based on this deficiency of the original examination, discretionary denial is unwarranted based on the same or similar art being applied in this petition.

XII. NO EVIDENCE OF NONOBVIOUSNESS

Petitioners are unaware of any objective indicia, and in any event, the strength of the grounds herein would render such evidence deficient.

XIII. CONCLUSION

For all the reasons discussed above, claims 1 and 11-14 of the '678 patent are unpatentable. Petitioners request that *inter partes* review be instituted and the claims canceled.

Date: December 9, 2024

Respectfully submitted,

/s/ David C. Radulescu

David C. Radulescu, Lead Counsel
Reg. No. 36,250

CERTIFICATE OF COMPLIANCE

Pursuant to 37 C.F.R. § 42.24(d), I hereby certify that this petition complies with the type-volume limitation of 37 C.F.R. § 42.24(a). The word count application of the word processing program used to prepare this petition indicates that the petition contains 11,637 words, excluding the parts of the brief exempted by 37 C.F.R. § 42.24(a).

Date: December 9, 2024

/s/ David C. Radulescu
David C. Radulescu, Lead Counsel
Reg. No. 36,250

PAYMENT OF FEES (37 C.F.R. §§ 42.15(A) AND 42.103)

The required fees are submitted herewith. If any additional fees are due at any time during this proceeding, the Office is authorized to charge such fees to Deposit Account No. DA606603.

APPENDIX A – EXHIBIT LIST

Exhibit No.	Description
EX1001	U.S. Patent No. 8,604,678
EX1002	Declaration of William A. Doolittle, Ph.D.
EX1003	Curriculum Vitae of William A. Doolittle, Ph.D.
EX1004	File History for U.S. Pat. Appl. No. 13/273,212 (excl. references)
EX1005	U.S. Pat. Pub. No. 2009/0057699 (“Basin-2007”)
EX1006	U.S. Pat. Pub. No. 2007/0045761 (“Basin-2005”)
EX1007	U.S. Pat. Pub. No. 2008/0079015 (“Krummacher”)
EX1008	U.S. Patent No. 6,791,259 (“Stokes”)
EX1009	U.S. Patent No. 5,998,925 (“Shimizu-APA”)
EX1010	U.S. Patent No. 6,069,440 (“Shimizu”)
EX1011	U.S. Pat. Pub. No. US2010/0124243 (“Hussell”)
EX1012	DuPont: Polymers, Light and the Science of TiO ₂ (2007)
EX1013	DuPont: Titanium Dioxide for Coatings (2007)
EX1014	Erik S. Thiele and Roger H. French, “Computation of Light Scattering by Anisotropic Spheres of Rutile Titania”, Adv. Mater. 1998, 10, No. 15
EX1015	Erik S. Thiele and Roger H. French, “Light-Scattering Properties of Representative, Morphological Rutile Titania Particles Studied Using a Finite-Element Method”, J. Am. Ceram. Soc., 81 [3] 469–79 (1998)
EX1016	Robert W. Johnson, Erik S. Thiele, And Roger H. French, “Light-scattering efficiency of white pigments: an analysis of model core - shell pigments vs. optimized rutile TiO ₂ ”, TAPPI JOURNAL, November 1997, Vol. 80(11)
EX1017	William D. Ross, “Theoretical Light-Scattering Power of TiO ₂ and Microvoids”, Ind. Eng. Chem., Prod. Res. Develop., Vol. 13, No. 1, 1974
EX1018	Feit Electric’s Initial Infringement Contentions - Claim Charts (May 28, 2024)
EX1019	U.S. Patent No. 8,547,010 (“Jagt”)
EX1020	Int’l Pat. Pub. No. WO 2008/044171 A2 (“Van Woudenberg”)
EX1021	Declaration of Etai Lahav
EX1022	Declaration of William A. Doolittle, Ph.D. regarding claims 11-14 of the ’678 patent
EX1023	Sudhakar Madhusoodhanan and Devdatt S. Nagvekar, “UV

Exhibit No.	Description
	Curable High Opacity Ink Jettable White Ink”, RadTech e 5 2006 Technical Proceedings (2006)
EX1024	U.S. Pat. Pub. No. 2011/0001151 (“Toquin”)

CERTIFICATE OF SERVICE

Pursuant to 37 C.F.R. §§ 42.6(e) and 42.105(a), I certify that I caused to be served a true and correct copy of the foregoing petition for *inter partes* review (and accompanying exhibits) by overnight courier (U.S. Postal Service, Federal Express, or UPS), on this date, on Patent Owner at the correspondence address of Patent Owner as follows:

Christopher P. Lightner
Alston & Bird LLP
Vantage South End
1120 South Tryon Street, Suite 300
Charlotte, NC 28203-6818

A courtesy copy was also sent to counsel for Patent Owner in IPR2024-01357 at the following email addresses:

Michael Pomeroy	mpomeroy@carterarnett.com
Alexis Ritzer	aritzer@carterarnett.com
Scott Breedlove	sbreedlove@carterarnett.com

Date: December 9, 2024

/s/David C. Radulescu
David C. Radulescu, Lead Counsel
Reg. No. 36,250