

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

Hisense USA Corp.,
Petitioner,

v.

Light Guide Innovations LLC,
Patent Owner

Case: IPR2025-01526
U.S. Patent No. 8,408,778

**DECLARATION OF MICHAEL R. KRAMES, PH.D. IN SUPPORT OF
PETITION FOR *INTER PARTES* REVIEW**

TABLE OF CONTENTS

I.	Introduction.....	1
II.	Qualifications.....	2
III.	Materials Considered.....	3
IV.	Legal Standards	5
	A. Level of Ordinary Skill	6
	B. Prior Art.....	7
	C. Anticipation	8
	D. Obviousness.....	9
V.	Claim Construction.....	11
VI.	The '778 Patent.....	12
	A. Overview	12
	B. Prosecution History and Effective Filing Date	14
	1. Examiner error regarding Kurihara.....	14
	2. Examiner error regarding Choi	17
	C. The Challenged Claims	18
	D. Person of Ordinary Skill in the Art (“POSITA”).....	18
	E. Priority Date	18
VII.	Overview of the Prior Art.....	19
	A. Asada (EX1004).....	19
	B. Kinoshita (EX1005)	21
	C. Ashdown (EX1006).....	22
	D. Cho (EX1007)	24
	E. Dejima (EX1010)	25
VIII.	GROUND 1: Asada in view of Kinoshita discloses, teaches, and suggests every limitation of claims 1-7, 11-14, and 23.....	26
	A. Scope and content of the art, overview of the combination, motivation/rationale for the combination, and expectation of success	26

B.	The Challenged Claims	30
IX.	Ground 2: Asada in view of Kinoshita and Dejima discloses, teaches, and suggests every limitation of claim 15	59
A.	Scope and content of the art, overview of the combination, motivation/rationale for the combination, and expectation of success	59
B.	The Challenged Claim.....	61
X.	Ground 3: Asada in view of Kinoshita and Ashdown discloses, teaches, and suggests every limitation of claims 8-10 and 24-26	63
A.	Scope and content of the art, overview of the combination, motivation/rationale for the combination, and expectation of success	63
B.	The Challenged Claims	68
XI.	Ground 4: Asada in view of Kinoshita and Cho discloses, teaches, and suggests every limitation of claims 20-22	72
A.	Scope and content of the art, overview of the combination, motivation/rationale for the combination, and expectation of success	72
B.	The Challenged Claims	75
XII.	DECLARATION IN LIEU OF OATH	81

PETITIONER'S EXHIBIT LIST

Exhibit No.	Description
1001	U.S. Patent No. 8,408,778 (“778 Patent”)
1002	File History of U.S. Patent No. 8,408,778 (“778FH”)
1003	Declaration of Michael Krames, Ph.D.
1004	Certified Translation of Japanese Patent Pub. No. 2005-332963 (P2005—332963A) (“Asada”)
1005	Certified Translation of Japanese Patent Pub. No. 2008-117879 (P2008—117879A) (“Kinoshita”)
1006	Ian Ashdown et al., <i>Binning and Filtering: The Six-Color Solution</i> , Sixth International Conference on Solid State Lighting (14-17 August 2006), also known as volume 6337 of the Proceedings of SPIE -- the International Society for Optical Engineering TK7871.89 .L53S64 2006
1007	Certified Translation of Korean Patent Pub. No. 10-2005-0105823 (“Cho”)
1008	U.S. Patent App. Pub. 2008/0285308 (“Clary”)
1009	International Patent No. WO 2007/055509 A1 (“Oh”)
1010	U.S. Patent App. Pub. 2006/0255711 (“Dejima”)
1011	U.S. Patent App. Pub. 2008/0158907 (“Lin”)
1012	U.S. Patent App. Pub. 2006/0268537 (“Kurihara”)
1013	U.S. Patent No. 7,350,937 (“Yamamoto”)
1014	U.S. Patent App. Pub. 2007/0147081 (“Choi”)
1015	Declaration of Prof. Sylvia Hall-Ellis, Ph.D.
1016	U.S. Patent App. Pub. 2002/0163525 (“Liao”)

Exhibit No.	Description
1017	ANSI_NSLG C78.377-2008, American National Standard for electric lamps—Specifications for the Chromaticity of Solid State Lighting Products
1018	EP 0 890 996 B1 to Tasaki (“Tasaki”)
1019	Japanese Patent Pub. No. 2005-332963 (P2005—332963A) (“JP-Asada”)
1020	Japanese Patent Pub. No. 2008-117879 (P2008—117879A) (“JP-Kinoshita”)
1021	Korean Patent Pub. No. 10-2005-0105823 (“KR-Cho”)

I, Michael R. Krames, Ph.D., declare as follows:

I. Introduction

1. I am over the age of 21 and am competent to make this declaration.
2. I have been retained on behalf of Petitioner Hisense Company Ltd. to provide my opinions regarding the validity of claims 1-15 and 20-26 (“Challenged Claims”) of U.S. Patent No. 8,408,778 (EX1001, the “’778 patent”). I submit this declaration based on my personal knowledge and in support of Hisense’s *inter partes* review Petition (the “Petition”) against the ’778 patent.
3. I have been asked to provide my independent analysis of the ’778 patent in light of the materials cited below and my knowledge and experience in this field during the relevant period. I have been asked to consider whether the references cited in the Petition render obvious the invention described by the Challenged Claims.
4. I am being compensated at my normal hourly rate for my time. My compensation is not contingent in any way on the content of my analysis or the outcome of this proceeding. I am not and never have been an employee or agent of Hisense.
5. My opinions are based on my study, experience, and background discussed below, informed by my extensive experience regarding the subject matter of the ’778 patent and the related prior art.

II. Qualifications

6. I have over thirty years of experience in compound semiconductors, with an emphasis on wide-bandgap semiconductor materials and devices and specifically including the field of light emitting diodes (“LEDs”). I have extensive experience in R&D and manufacturing settings, creating innovative LEDs and LED-based products for various solid-state lighting applications. I am a Fellow of the Institute of Electrical and Electronics Engineers (IEEE) and a Fellow of the Illuminating Engineering Society (IES), and a member of the U.S. National Academy of Engineering (NAE).

7. Currently, I am the President of Arkesso LLC, which is a consulting firm specializing in wide bandgap semiconductors and applications.

8. From 2009 to 2015, I was the Chief Technology Officer at Soraa, Inc, where I worked with Nobel Prize winner Shuji Nakamura and other key innovators from the University of California, Santa Barbara, to develop leading LED products for professional directional lighting by creating a new LED materials platform based on bulk gallium-nitride substrates (GaN-on-GaN).

9. I was also the Executive Vice President of Advanced Laboratories at Philips Lumileds/Lumileds Lighting and was a design engineer and engineering scientist at Hewlett Packard Co. While at Philips Lumileds/Lumileds Lighting (from 1999-2009), I developed key innovations behind the LUXEON high power LED

platform and managed the advanced technology roadmaps, identified Auger recombination as the primary loss mechanism in InGaN-based LEDs, and designed LED solutions for the iMac, iPhone Flash, digital imaging, and general illumination. My contributions there also led to the first automotive LED headlights for the Audi R8.

10. I am a named inventor on 176 U.S. granted patents in the fields of LEDs and wide bandgap semiconductors and am a named author on over 100 publications in these fields.

11. In 1989, I earned a Bachelor of Science in Electrical Engineering with High Honors from the University of Texas in Austin, TX.

12. In 1995, I earned a Ph.D. in Electrical Engineering from the University of Illinois Urbana-Champaign in Urbana, IL, under the supervision of Prof. Nick Holonyak, Jr., the original inventor of the LED.

13. My Curriculum Vitae is provided as Appendix A, which contains further details on my education, experience, publications, and other qualifications.

III. Materials Considered

14. As described in more detail below, based on my experiences, I understand and know the capabilities of a person of ordinary skill in the art of the '778 patent in 2009, when the application to which the '778 patent claims priority was filed. I have relevant personal knowledge and experience, in addition to working directly with

many such persons in these fields during that time frame.

15. I have also relied on my review and analysis of the prior art cited in the Petition, information provided to me in connection with this case, and information I have independently reviewed.

16. In forming my opinions, I have been asked to review the '778 patent including the specification and the Challenged Claims. I have also considered the materials cited herein, including those itemized in the Table of Exhibits that precedes this declaration.

17. My opinions are based on the materials I reviewed and my knowledge and professional judgment. My opinions have also been guided by my understanding of how a person of ordinary skill in the art would have understood the claims of the '778 patent in the relevant time frame.

18. I also understand from counsel that the prior art references cited herein qualify as prior art under U.S. law.

19. In my analysis below, emphasis in my citations has been added unless otherwise noted. Likewise, annotations to images and figures (typically highlighting of various colors) have been added unless otherwise noted.

20. I reserve the right to supplement and amend any of my opinions in this declaration based on documents, testimony, and other information that becomes available to me after the date of this declaration.

IV. Legal Standards

21. I am not a lawyer. My understanding of the legal standards to apply in reaching the conclusions in this declaration is based on discussions with counsel for Petitioner, my experience applying similar standards in other patent-related matters, and my reading of the documents submitted in this proceeding. In preparing this declaration, I have tried to faithfully apply these legal standards to the challenged claims.

22. I have been informed that there are two ways in which prior art may render a patent claim unpatentable. First, I have been informed that the prior art can “anticipate” a claim. Second, I have been informed that the prior art can render a claim “obvious” to a person of ordinary skill in the art. I understand that a claim is patentable if it was not anticipated and would not have been obvious by the prior art at the effective filing date of the patent. In this declaration, I only address obviousness.

23. I have been informed that a dependent claim is a patent claim that refers back to another patent claim. I have been informed that a dependent claim includes all of the limitations of the claim to which it refers.

24. I have been asked to provide my opinions as to whether the cited prior art renders obvious the Challenged Claims of the ’778 patent from the perspective of a person of ordinary skill in the art at the ’778 patent’s earliest possible effective filing

date in 2009, as described in more detail below.

25. I have been informed that in *inter partes* review proceedings, such as this one, the party challenging the patent bears the burden of proving unpatentability by a preponderance of the evidence. I understand that a preponderance of the evidence means “more likely than not.”

26. For purposes of this declaration, I have been asked to provide my opinions on issues regarding unpatentability. I have been informed of the following legal standards, which I have applied in forming my opinions.

A. Level of Ordinary Skill

27. I understand that my assessment of the claims of the ’778 patent must be undertaken from the perspective of what would have been known or understood by a person having ordinary skill in the art, reading the ’778 patent on its priority date and in light of the specification and file history of the ’778 patent. I will refer to such a person as a “POSITA.”

28. I understand that my analysis and opinions expressed in this declaration must be rendered based on the perspective of a POSITA as of the priority date of the ’778 patent. I also understand that a POSITA is a hypothetical person who is presumed to know the relevant art at the time of the alleged invention claimed in the ’778 patent.

29. I further understand that in determining the level of ordinary skill in the

art, I am to consider factors including:

- the type of problems encountered in the art or field of invention,
- prior art solutions to those problems,
- the rapidity with which innovations are made,
- sophistication of the technology, and
- the educational level of active workers in the field.

30. I have been instructed to assume a person of ordinary skill in the art is not a specific real individual, but rather a hypothetical individual having the qualities reflected by the factors discussed above.

31. I understand that a POSITA is a person of ordinary creativity, but not an automaton, and that a POSITA can often fit multiple patents or prior art references together like pieces of a puzzle as a result of this ordinary creativity. I also understand that I may consider the inferences and creative steps that a POSITA would employ. In addition, I understand that a POSITA would necessarily have been capable of understanding the scientific and engineering principles applicable to the pertinent art. I also understand that when I consider what would have been obvious to a POSITA, I am not considering what would have been obvious to me at the time, nor to the inventors, judges, laymen, those skilled in other arts, or to geniuses in the art.

B. Prior Art

32. I have been advised and understand that the information used to evaluate whether an invention was new and not obvious when made is generally referred to

as “prior art.” I understand that prior art includes patents and printed publications that existed before the earliest claimed priority date or the earliest filing date of the patent (which I have been informed is also called the “effective filing date”).

33. I have been informed and understand that a patent or published patent application is prior art if it was filed before the effective filing date of the claimed invention.

34. I have also been informed and understand that a printed publication is prior art if it was publicly available before the earliest filing date and could be located by a POSITA exercising reasonable diligence.

C. Anticipation

35. I understand that a patent is invalid as anticipated if each and every feature of the claim is found, expressly or inherently, in a single item of prior art. I understand that anticipation by inherent disclosure is appropriate only when a prior art reference necessarily includes or discloses the unstated claim element. I also understand that the discovery of a new or previously unreported or unappreciated property of a prior art composition, or of a scientific explanation for how a prior art composition operates, does not make the prior art composition patentably new to the entity or person that discovered the new property or mode of operation.

36. For anticipation by a prior art publication or document, I understand that the reference’s description must enable a POSITA to practice the claimed invention

D. Obviousness

37. I understand that a claim may be invalid if the subject matter described by the claim as a whole would have been obvious to a POSITA in view of a prior art reference, or in view of a combination of references at the time the claimed invention was made. Therefore, I understand that obviousness is determined from the perspective of a POSITA, and that the asserted claims of the patent should be read from the point of view of such a person at the time the claimed invention was made. I further understand that a POSITA is assumed to know and to have all relevant prior art in the field of endeavor covered by the patent in suit and all analogous prior art. I understand that obviousness in an *inter partes* review proceeding is evaluated using a preponderance of the evidence standard, which means that the claims must be more likely obvious than nonobvious.

38. I also understand that an analysis of whether a claimed invention would have been obvious should be considered in light of the scope and content of the prior art, the differences (if any) between the prior art and the claimed invention, and the level of ordinary skill in the pertinent art involved. I understand as well that a prior art reference should be viewed as a whole. I understand that in considering whether an invention for a claimed combination would have been obvious, I may assess whether there are apparent reasons to combine known elements in the prior art in the

manner claimed in view of interrelated teachings of multiple prior art references, the effects of demands known to the design community or present in the marketplace, and/or the background knowledge possessed by a POSITA. I also understand that other principles may be relied on in evaluating whether a claimed invention would have been obvious, and that these principles include the following:

- A combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results;
- When a device or technology is available in one field of endeavor, design incentives and other market forces can prompt variations of it, either in the same field or in a different one, so that if a POSITA can implement a predictable variation, the variation is likely obvious;
- If a technique has been used to improve one device, and a POSITA would have recognized that it would improve similar devices in the same way, using the technique is obvious unless its actual application is beyond his or her skill;
- An explicit or implicit teaching, suggestion, or motivation to combine two prior art references to form the claimed combination may demonstrate obviousness, but proof of obviousness does not depend on or require showing a teaching, suggestion, or motivation to combine;
- Market demand, rather than scientific literature, can drive design trends and may show obviousness;
- One of the ways in which a patent's subject can be proved obvious is by noting that there existed at the time of invention a known problem for which there was an obvious solution encompassed by the patent's claims;
- Any need or problem known in the field of endeavor at the time of invention and addressed by the patent can provide a reason for combining the elements in the manner claimed;
- "Common sense" teaches that familiar items may have obvious uses beyond their primary purposes, and in many cases a POSITA will be able to fit the teachings of multiple patents together like pieces of a puzzle;
- A POSITA is also a person of ordinary creativity, not an automaton;

- A patent claim can be proved obvious by showing that the claimed combination of elements was “obvious to try,” particularly when there is a design need or market pressure to solve a problem and there are a finite number of identified, predictable solutions such that a POSITA would have had good reason to pursue the known options within his or her technical grasp; and
- One should be cautious of using hindsight in evaluating whether a claimed invention would have been obvious.

39. I have been informed that the relevant time for considering whether a claim would have been obvious to a person of ordinary skill in the art is the time of invention. For my obviousness analysis, counsel for Petitioner instructed me to assume that the effective filing date is February 17, 2009, and that I should assume this is the date of invention for the Challenged Claims. My opinions regarding the appropriate skill level of a POSITA would not change if I assumed a later date of invention, e.g., if the alleged invention is not entitled to a February 17, 2009 filing date.

V. Claim Construction

40. I understand that claim terms in an IPR are generally interpreted according to their ordinary and customary meaning. I further understand that the claims are read in light of the patent’s specification and that claims themselves often provide significant guidance as to the meaning of a particular term. I also understand that extrinsic evidence may be helpful when construing a claim term, but that it is less relevant than the intrinsic evidence and is often unreliable.

41. The prior art discussed herein would disclose and/or obviate the

Challenged Claims under any reasonable constructions, and thus, I believe no formal claim constructions are required.

VI. The '778 Patent

A. Overview

42. The “Field” of the '778 patent relates to a light source. (EX1001 at 1:14-16.)

43. The Background describes backlighting for LCD display panels:

“Display devices may include a cathode ray tube (CRT), a liquid crystal display device (LCD), a plasma display panel (PDP), and an electroluminescent display (ELD). LCDs may display an image by controlling an amount of light incident from the outside. Thus, a backlight assembly may be used to irradiate light onto a liquid crystal panel and display an image.”

(EX1001 at 1:17-24.)

44. The patent also describes and illustrates various embodiments, and indicates that the relative positioning of layers within the embodiments should be understood broadly:

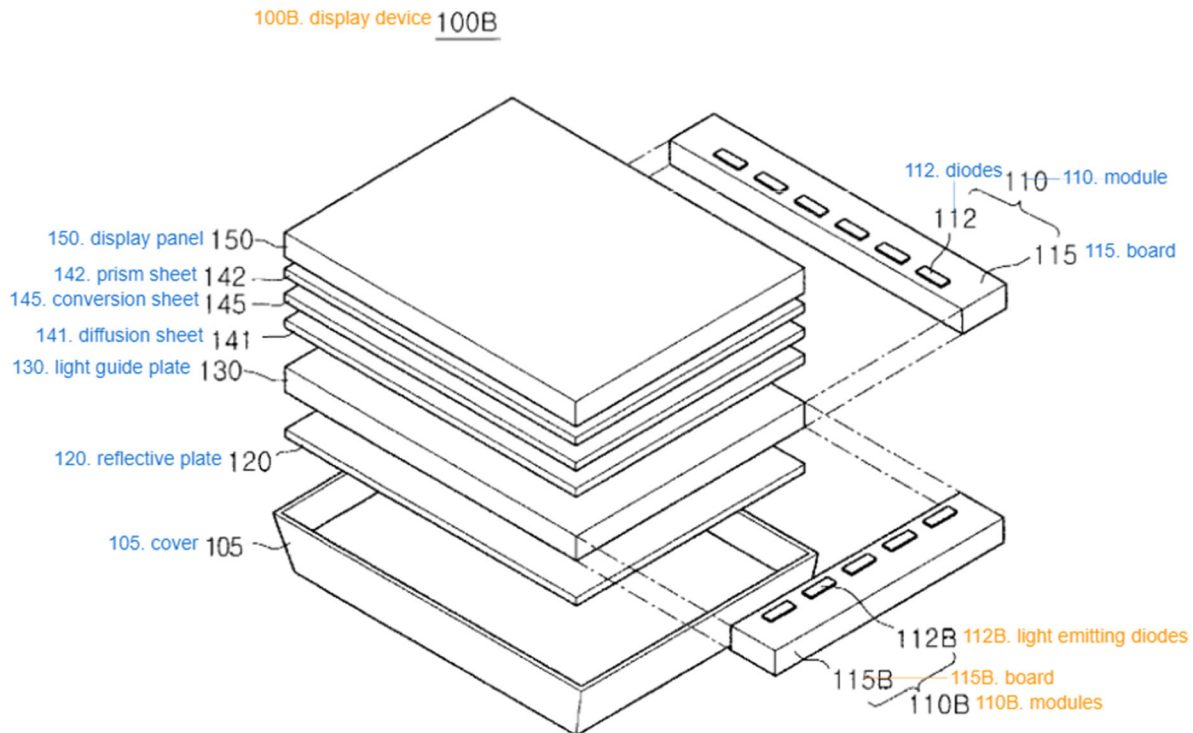
“Reference will now be made in detail to various embodiments, examples of which are illustrated in the accompanying drawings. In description of embodiments, it will be understood that in a case where a layer (or sheet), a region, a pattern, or components is referred to as being ‘on’ or ‘under’ another substrate, layer (or film), region or patterns, the ‘on’ and ‘under’ include all the meanings of ‘directly’ and ‘indirectly’. Further, references to ‘on’ and ‘under’ each layer

will be made based on the exemplary illustration in drawings. Also, the thickness of each layer in the drawings is exemplary, and is not limited thereto.”

(EX1001 at 1:57-67.)

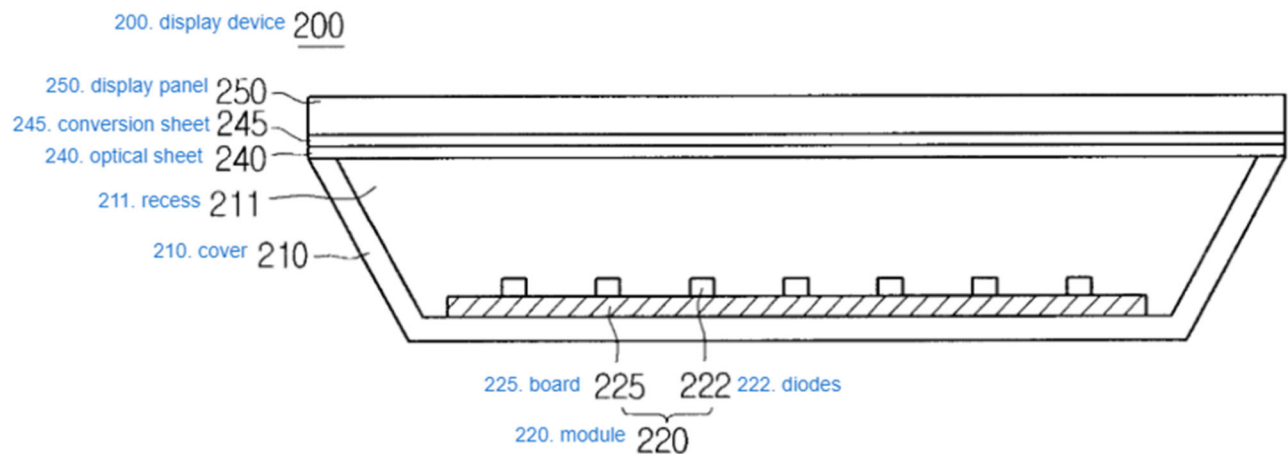
45. The figures highlight conventional implementation details, including layer positioning:¹

FIG. 5



¹ Annotations, labels, and highlighting in this declaration are added unless otherwise noted.

FIG. 6



(EX1001 at FIG. 5 (described at 5:43-67), FIG. 6 (described at 6:1-32; *see id.* at FIGS. 7-8.)

B. Prosecution History and Effective Filing Date

46. I understand that the prosecution of the '778 patent at the USPTO was minimal. I understand there was one office action rejecting the claims and then a notice of allowance identifying another prior art reference (Choi).

47. I also understand that Petitioner describes the conduct before the USPTO in more detail. I do not repeat that discussion here, but have been asked to consider whether the examiner erred when analyzing two references: Kurihara (EX1012) and Choi (EX1014).

1. Examiner error regarding Kurihara

48. First, I understand that the examiner considered the Kurihara reference and stated:

“Kurihara neither discloses nor suggests an optical sheet on a top surface of the light guide plate, and a conversion sheet provided on a top surface of the optical sheet, wherein the conversion sheet converts a color of the light emitted by the at least one light emitting module to a target color, wherein the optical sheet includes a diffusion sheet and a prism sheet aligned with the diffusion sheet, and wherein the optical sheet is disposed on the light guide plate and the conversion sheet such that the conversion sheet converts the color of the light passing through the diffusion sheet and the prism sheet, as recited in independent claim 1....”

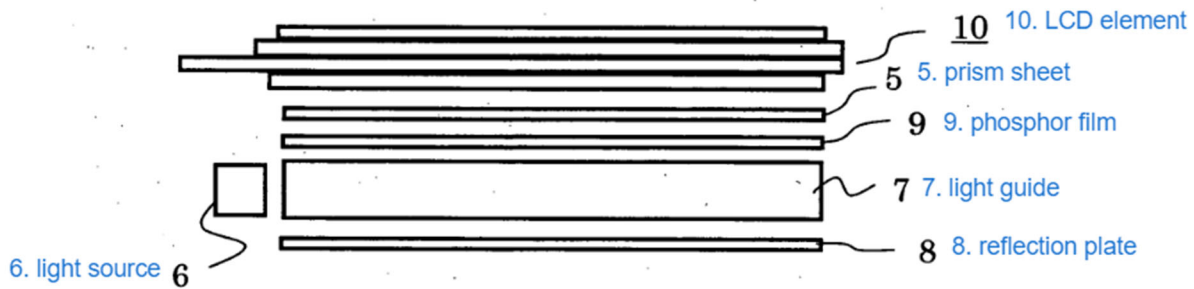
(*Id.* at 262-63; *see id.* at 263 (further characterizing Kurihara).)

49. The examiner missed key disclosures in Kurihara and came to the wrong conclusion in the excerpt above. Specifically, the examiner does not appear to have considered Kurihara’s FIG. 5 and related discussion, which teach the elements that were allegedly missing. (*See* EX1002 at 234-239.)

50. FIG. 5 and Kurihara’s discussion thereof disclose an optical sheet including a prism sheet, a diffuser sheet and a phosphor film (conversion sheet) between or above such sheets:

“[I]f the phosphor film 9 is set in any one of [the] optical paths of the light emitted from the light source 6 reaching the liquid crystal display element 10, it is possible to obtain the effect of the invention. A diffuser and plural prism sheets may be placed on the upper surface of the light guide 7.”

Fig. 5



(EX1012-Kurihara at FIG. 5, 0077.)

51. Kurihara also discloses the conventional functionality of a conversion sheet: phosphor film 9 converts a color of the light emitted by the at least one light emitting module to a target color:

“[T]he phosphor film 9 is set between the light source 6 and the light guide 7. Light emitted from the light source 6 passes through the phosphor film 9 to be converted into light having a desired wavelength. The converted light is guided in a direction of a liquid crystal display element 10 by the light guide 7, the reflection plate 8, and the prism sheet 5 and sampled by a color filter provided in the liquid crystal display element 10 to emit light of a display color.”

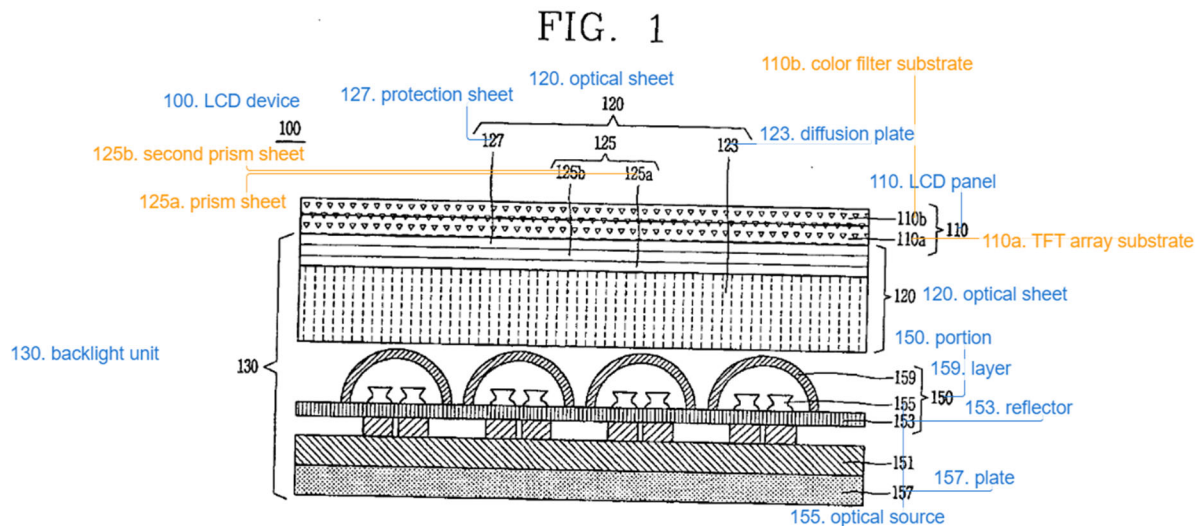
(EX1012-Kurihara at 0072; *see id.* at 0077 (“A display device having a structure in which the phosphor film 9 is arranged on an upper surface of the light guide 7 is shown in FIG. 5. The same effect is obtained when the phosphor film 9 is placed between the light guide 7 and the reflection plate 8. In other words, if the phosphor film 9 is set in any one of optical paths of the light emitted from the light source 6 reaching the liquid crystal display element 10, it is possible to obtain the effect of

52. As shown above, the examiner reached erroneous conclusions regarding Kurihara.

2. Examiner error regarding Choi

53. I also understand that the examiner identified Choi as the “closest prior art” in the Notice of Allowance. This reference had not previously been discussed during prosecution. I have been asked to consider the examiner’s characterization of Choi.

54. Choi’s figures disclose a conventional backlighting arrangement rather than side-emission and thus Choi does not illustrate a light guide plate in its device:



(EX1014-Choi at FIG. 1.)

55. Choi also lacks a fluorescent (phosphor) conversion layer, so it is difficult to understand how Choi could have been deemed relevant to the features that were allegedly missing from other references discussed during prosecution – let alone

C. The Challenged Claims

56. I understand that Petitioner is challenging claims 1-15 and 20-26 (collectively, the “Challenged Claims”). Claims 1, 20, and 23 are independent claims.

D. Person of Ordinary Skill in the Art (“POSITA”)

57. After considering the factors identified above regarding the level of ordinary skill in the art and my own experience in the field of the ’778 patent, in my opinion a POSITA as of February 17, 2009 would have had at least 2 years of experience in LED-based lighting device design and fabrication as well as at least a Bachelor’s degree in a relevant field (e.g., chemical engineering, materials engineering, or electrical engineering), or alternatively would have an equivalent combination of advanced education and practical experience, such as a Ph.D. based on work involving LED-based lighting device design and fabrication.

58. A POSITA also would have been knowledgeable regarding backlighting devices that use LED and fluorescent/phosphor-based conversion materials.

59. Additional techniques and tools understood by a POSITA are discussed in this Declaration.

E. Priority Date

60. I have been instructed to assume that the ’778 patent is entitled to a February 17, 2009, priority date based on a priority claim to a Korean application.

VII. Overview of the Prior Art

61. I understand that the Petition addresses the following grounds:

Ground	Claims	References
1	1-7 11-14, 23	§103 Asada in view of Kinoshita
2	15	§103 Asada in view of Kinoshita and Dejima
3	8-10, 24-26	§103 Asada in view of Kinoshita and Ashdown
4	20-22	§103 Asada in view of Kinoshita and Cho

62. I provide a brief overview of the prior art references identified in Petitioner's grounds below.

63. Each reference discussed below and relied upon in the challenges is analogous prior art.

64. Each reference discussed below is also in the same field of endeavor as the '788 Patent.

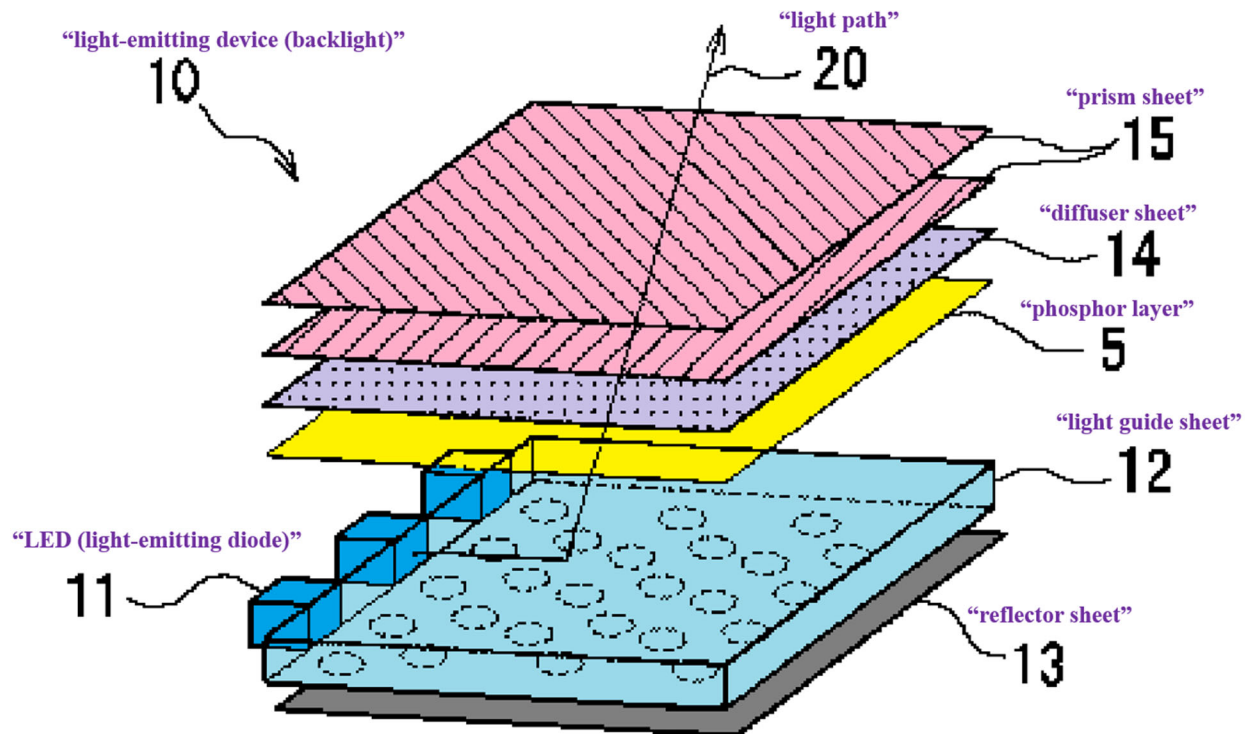
A. Asada (EX1004)

65. Asada is Japanese Patent Pub. No. 2005-332963 (P2005—332963A). I understand Asada qualifies as prior art. I also understand that EX1004 includes a certified translation of Asada and translation certification, and that EX1019 is the original Japanese version.

66. Asada discloses a backlighting light source that includes LEDs (11,

U.S. Patent No. 8,408,778

highlighted blue), a light guide sheet (12, light blue), a reflector sheet (13, gray), a diffuser sheet (14, purple), a prism sheet (15, pink) and phosphor particles (8, not shown) in a phosphor layer (5, yellow):



(EX1004-Asada, FIG. 2, 0045; *see id.* at 0039-41.)

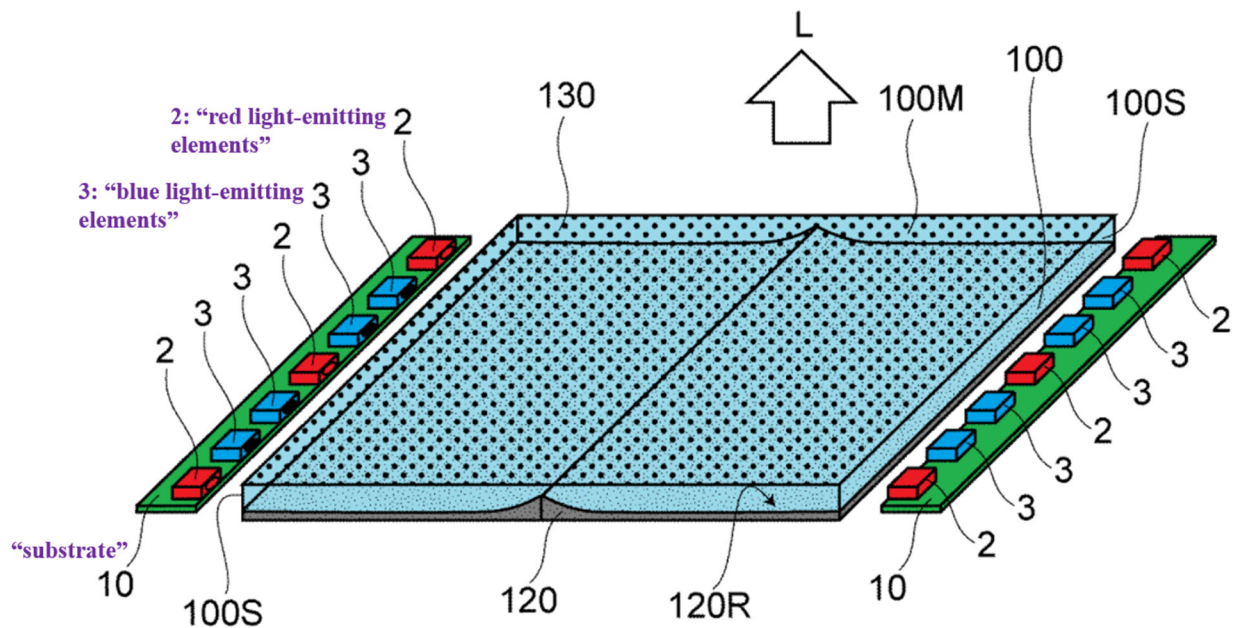
67. Asada is analogous to the '778 patent because both relate to lighting devices, and especially to LED-based edge-lit backlight devices. (EX1001 at FIGS. 1, 3-5; EX1004-Asada at FIG. 2, 0039-41.)

68. Asada is also reasonably pertinent to a problem to be solved by the '778 patent's alleged inventor, namely the improvement of lighting devices using wavelength conversion to obtain improved light output of a desired color. (*E.g.*, EX1001 at FIGS. 5-6 & 5:43-6:32; EX1004-Asada at FIG. 2, 0006-11, 0039-41.)

B. Kinoshita (EX1005)

69. Kinoshita is Japanese Patent Pub. No. 2008-117879 (P2008—117879A). I understand Kinoshita qualifies as prior art. I also understand that EX1005 includes a certified translation of Kinoshita and translation certification, and that EX1020 is the original Japanese version.

70. Kinoshita discloses another backlighting light source that may include red LEDs (2, red) and blue LEDs (3, blue) mounted on a substrate (10, green), and an edge-lit light guide plate (100, light blue) above a reflecting plate (120, gray):



(EX1005-Kinoshita at FIG. 1, 0012-17.)

71. Kinoshita is analogous to the '778 patent because both relate to lighting devices, and especially to LED-based side-emitting backlight devices. (EX1001 at 1:17-24 (“Background” section stating “a backlight assembly may be used to

irradiate light onto a liquid crystal panel and display an image”), FIGS. 1, 3-5 (illustrating edge-lit devices); EX1005-Kinoshita at FIG. 1, 0012-17.)

72. Kinoshita is also reasonably pertinent to a problem to be solved by the ’778 patent’s alleged inventor, namely the improvement of lighting devices using wavelength conversion to obtain improved light output of a desired color. (*E.g.*, EX1001 at FIGS. 5-6 & 5:43-6:32; EX1005-Kinoshita at 0011 (“The present invention is able to provide a planar light-emitting device that can stably obtain a specified chromaticity and luminance balance while holding down cost”), *see id.* at FIG. 1, 0008-10.)

C. Ashdown (EX1006)

73. Ashdown is a conference paper published in the *Sixth International Conference on Solid State Lighting*, also known as volume 6337 of the *Proceedings of SPIE -- the International Society for Optical Engineering*. (EX1015-Hall-Ellis at §V.) I understand that Ashdown qualifies as prior art based at least on the date that it was available from libraries and electronic repositories.

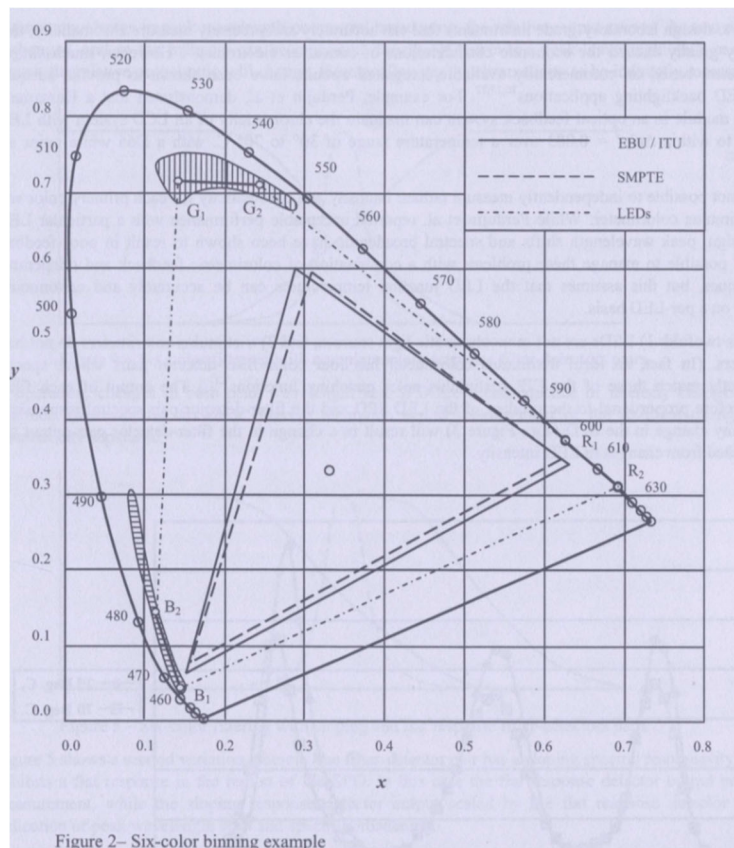
74. Ashdown discloses LEDs of different color coordinate distributions within the blue color spectrum may be used together:

“These laws form the basis of our ‘six-color’ binning solution. Referring to Figure 2, it is sufficient to choose at least two LEDs of each color whose chromaticities result in a hexagonal color gamut that subsumes the display phosphor chromaticities. In accordance

with Grassman's second law, it is evident that the luminous flux output from two or more LEDs with the same nominal color (red, green, or blue) can be blended to produce a composite third color whose saturation is approximately equal to that of the individual LEDs."

(EX1006-Ashdown at 63371A-6; *see id.* at 63371A-5-6 ("designs wherein the LEDs provide illumination for an edge-lit diffuser only requires that the mixed color of the LEDs meet the display primary chromaticity requirements. As noted by Folkerts et al., this allows a wider range color bins to be employed.")).

75. For example, Ashdown teaches that at least two blue LEDs B1 and B2 may be used together, despite having different color coordinates:



“A more efficient approach is to choose two or more LEDs for each color such that the desired chromaticity (as indicated in Table 1) is between the chromaticities of the LEDs, such as for example G1 and G2 as shown in Figure 2. The LEDs are then simultaneously driven using pulse and/or analog modulation to produce the desired chromaticities. Further, the ratio of drive currents for each color can be dynamically adjusted to maintain these chromaticities regardless of changes in the LED chromaticities due to peak wavelength shifts and spectral broadening. The primary advantage of six-color binning is that the LEDs do not need to be carefully binned. This should improve the yield of LEDs destined for backlighting applications and thereby lower the overall system cost.”

(EX1006-Ashdown at 63371A-7, Figure 2.)

76. Ashdown is analogous to the '778 patent because both relate to lighting devices, and especially to LED-based edge-lit backlight devices. (EX1001 at 1:17-24, FIGS. 1, 3-5 (illustrating edge-lit devices); EX1006-Ashdown at 63371A-5-6.) Ashdown is also reasonably pertinent to a problem faced by the alleged inventor of the '778 patent, including the use of LEDs of different ranks without needing to incur the cost associated with careful binning. (EX1001 at 2:44-3:19; EX1006-Ashdown at 63371A-7, Figure 2.)

D. Cho (EX1007)

77. Cho is Korean Patent No. 10-0664982. I understand Cho qualifies as prior art. I also understand that EX1007 includes a certified translation of Cho and

translation certification, and that EX1021 is the original Korean version.

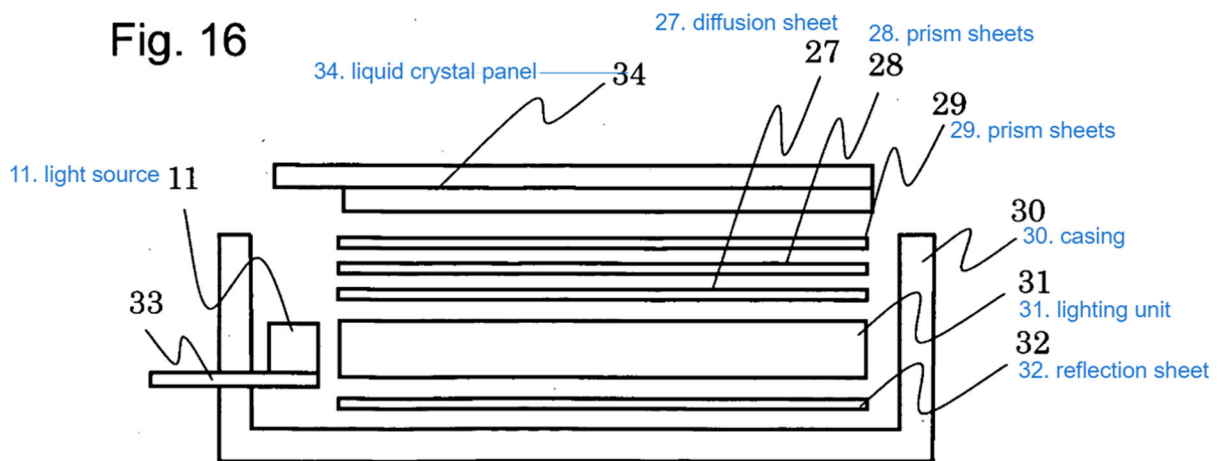
78. Cho discloses an edge-lit light source that is fixed within a cover and used as a backlighting device for LCD display panels. (EX1007-Cho at FIGS. 2-5, 5 (“Meanwhile, the substrate 12 on which a plurality of LEDs 14 are mounted as described above is inserted and fixed within the light source cover 16.”), 7 (defining callout 16 as “light source cover”).)

79. Cho is analogous to the ’778 patent at least because both relate to edge-lit light sources. (EX1001 at 1:17-24, FIGS. 1, 3-5 (illustrating edge-lit devices); EX1007-Cho at 5, FIGS. 2-5.)

E. Dejima (EX1010)

80. Dejima is U.S. Patent App. Pub. 2006/0255711. I understand Dejima qualifies as prior art.

81. Dejima discloses an edge-lit backlighting device within a cover (“casing 30”) having sidewalls, as shown in FIG. 16:



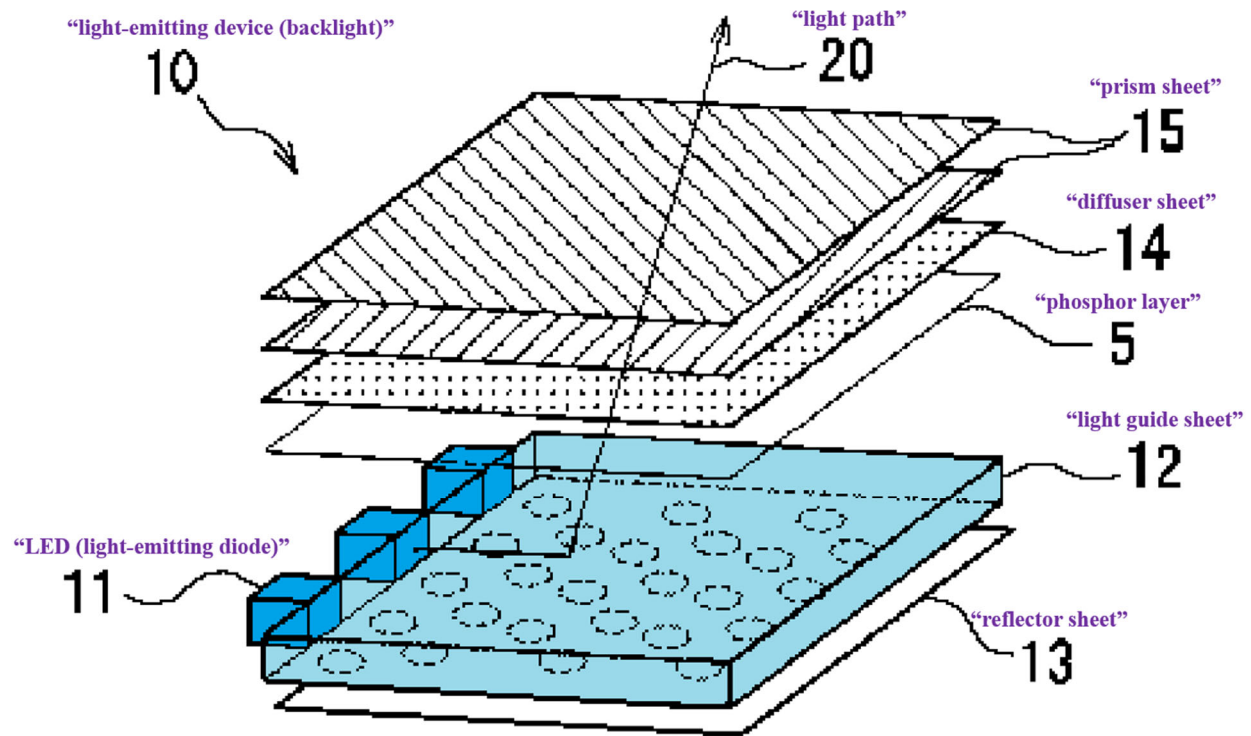
82. Dejima is analogous to the '778 patent at least because both relate to edge-lit light sources. (EX1001 at 1:17-24, FIGS. 1, 3-5 (illustrating edge-lit devices); EX1010-Dejima at 0068, FIG. 16.)

VIII. GROUND 1: Asada in view of Kinoshita discloses, teaches, and suggests every limitation of claims 1-7, 11-14, and 23

A. Scope and content of the art, overview of the combination, motivation/rationale for the combination, and expectation of success

83. As I discuss further below, Asada discloses most of the limitations of claim 1. The exception relates to whether the LEDs used in Asada are part of an LED module. In the '778 patent, for example, a “light emitting module...may include a board 115 and a plurality of light emitting diodes 112.” (EX1001 at 2:15-16.) except

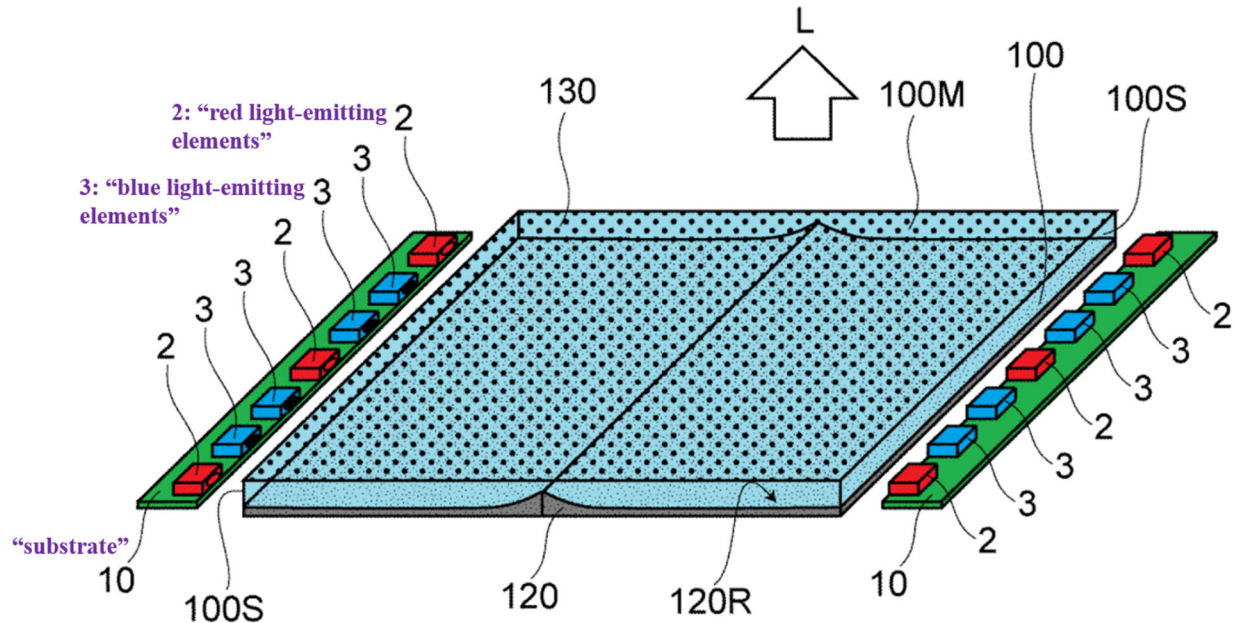
84. More particularly, Asada's FIG. 2 depicts a device comprising three LEDs (11, highlighted dark blue). The LEDs emit light into the light guide plate (12, highlighted light blue) as shown by light path 20:



(EX1004-Asada at FIG. 2.)

85. Asada does not expressly state whether the LEDs are part of a larger “module.” However, it would have been common for a POSITA to use LEDs 11 that are part of a module.

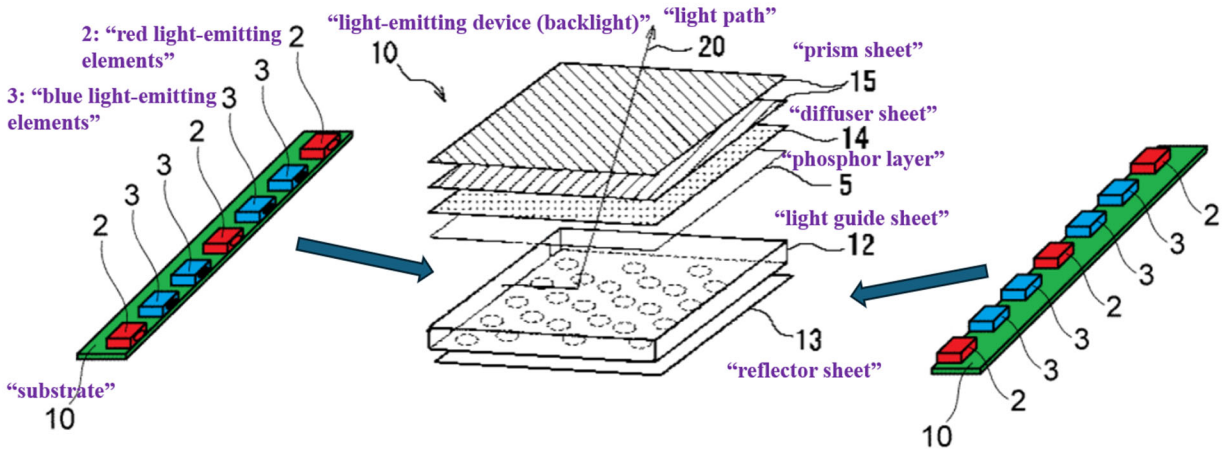
86. Like Asada, Kinoshita discloses a light guide plate 100 having LEDs located on sides thereof:



(EX1005-Kinoshita at FIG. 1, 0012-13.)

87. Kinoshita's LEDs are mounted on a board (substrate 10) to form a light-emitting module, and may include "red light-emitting elements 2 and blue light-emitting elements 3." (*Id.* at 0013.) The LEDs are mounted such that "their light emission is transverse to the main 20 surface of the substrate 10, that is, incident on the side surfaces 100S of the light guide plate 100." (*Id.*)

88. A POSITA would have been motivated and found it obvious to use Kinoshita's light-emitting modules to provide edge lighting for Asada's edge-lit device. A simple illustration of the combination is illustrated below:



89. A POSITA would have been motivated and found it obvious to apply Kinoshita's LED substrate/module teachings in Asada for several reasons. First, utilizing a substrate comprising LEDs was conventional, including in the manner shown by Kinoshita.

90. Second, the use of Kinoshita's substrates would have simplified the production of Asada's device. Rather than aligning and attaching individual LEDs for use in Asada's backlighting device, Kinoshita's LED modules allow for prefabrication, improve stability, and allow easier wiring/interconnecting of the LEDs. Kinoshita's LED modules also facilitate higher luminance and increased brightness for larger displays, both by including more than the three LEDs shown along a given edge of Asada's device and by teaching that LED modules may be used along one, two, three, or four edges of the device.

91. It also would have been simple to use Kinoshita's LED modules in Asada's device, by simply replacing the individual LEDs that are shown in Asada's figure

with Kinoshita's LED modules, then connecting them appropriately. They would have been used to perform the same function (edge lighting) as Asada's LEDs, and there would not have been anything unpredictable or unfamiliar to a POSITA in doing so.

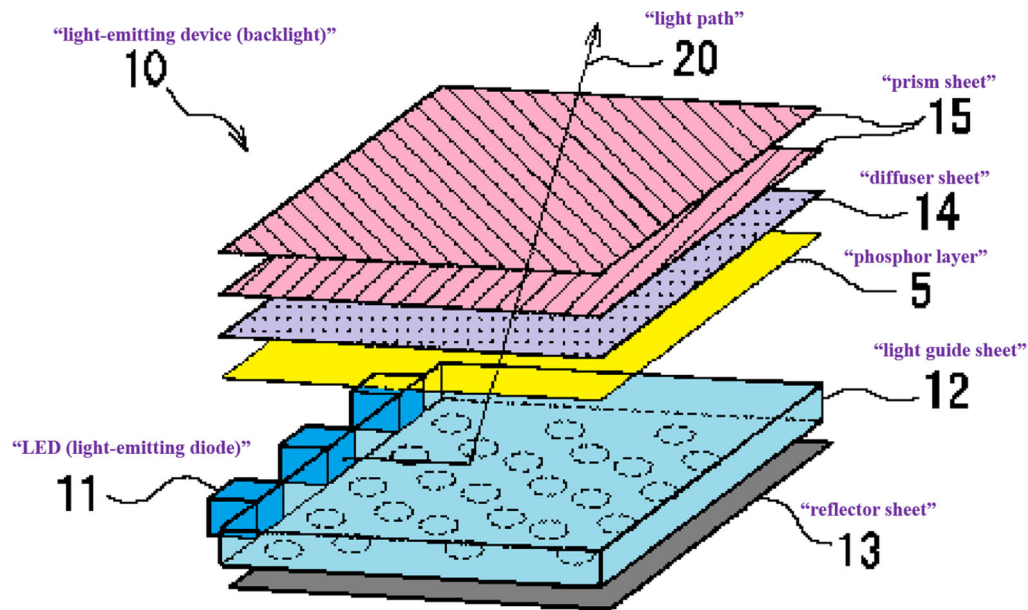
92. A POSITA also would have had no difficulty combining Asada and Kinoshita. The two references have related teachings, are in the same field as the '778 patent, and describe similar edge-lit LED-based backlighting devices. It would have been straightforward to substitute Asada's individual LEDs for Kinoshita's LED modules, and a POSITA would have had all of the necessary skills to ensure the mechanical and electrical connections that had been used for Asada's individual LEDs are configured for use with Kinoshita's LED substrates. The use of LED modules for edge-lighting was also well known before the '778 patent, so a POSITA would thus have had no difficulty utilizing Kinoshita's LED modules with Asada's lighting device. While Kinoshita emphasizes combining red and blue LEDs, it also would have been simple and straightforward to use only blue LEDs for the light-emitting modules, and to use other LED color combinations if desired, and still satisfy the requirements of Asada's device.

B. The Challenged Claims

Claim 1: [1Pre] "A light source, comprising:"

93. Asada discloses this preamble.

94. FIG. 2 depicts “a light-emitting device (backlight):”



“The *light-emitting device (backlight) 10* comprises an LED (light-emitting diode) 11, a light guide sheet (light guide member) 12, a reflector sheet 13, a diffuser sheet 14, and a prism sheet 15.”

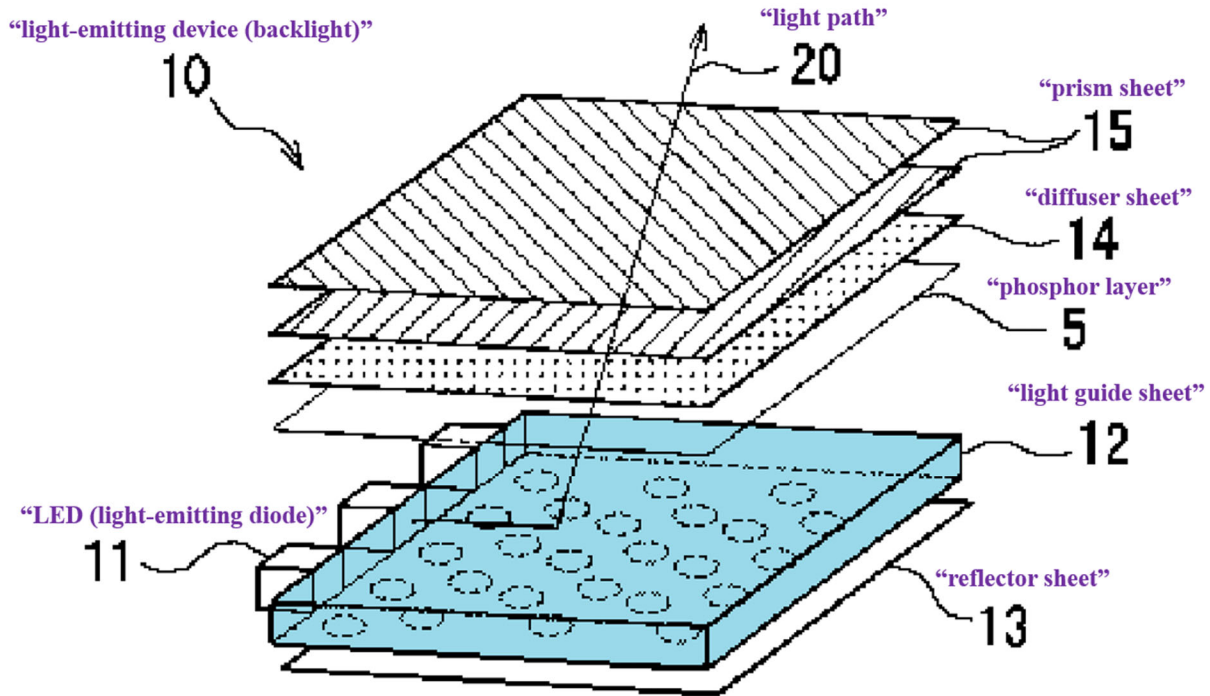
(EX1004-Asada at FIG. 2, 0040.)

95. Thus, Asada discloses the preamble.

[1A] “a light guide plate;”

96. Asada discloses this limitation.

97. FIG. 2 depicts “a light guide sheet 12” (highlighted light blue):



“The light-emitting device (backlight) 10 comprises an LED (light-emitting diode) 11, a light guide sheet (light guide member) 12, a reflector sheet 13, a diffuser sheet 14, and a prism sheet 15.”

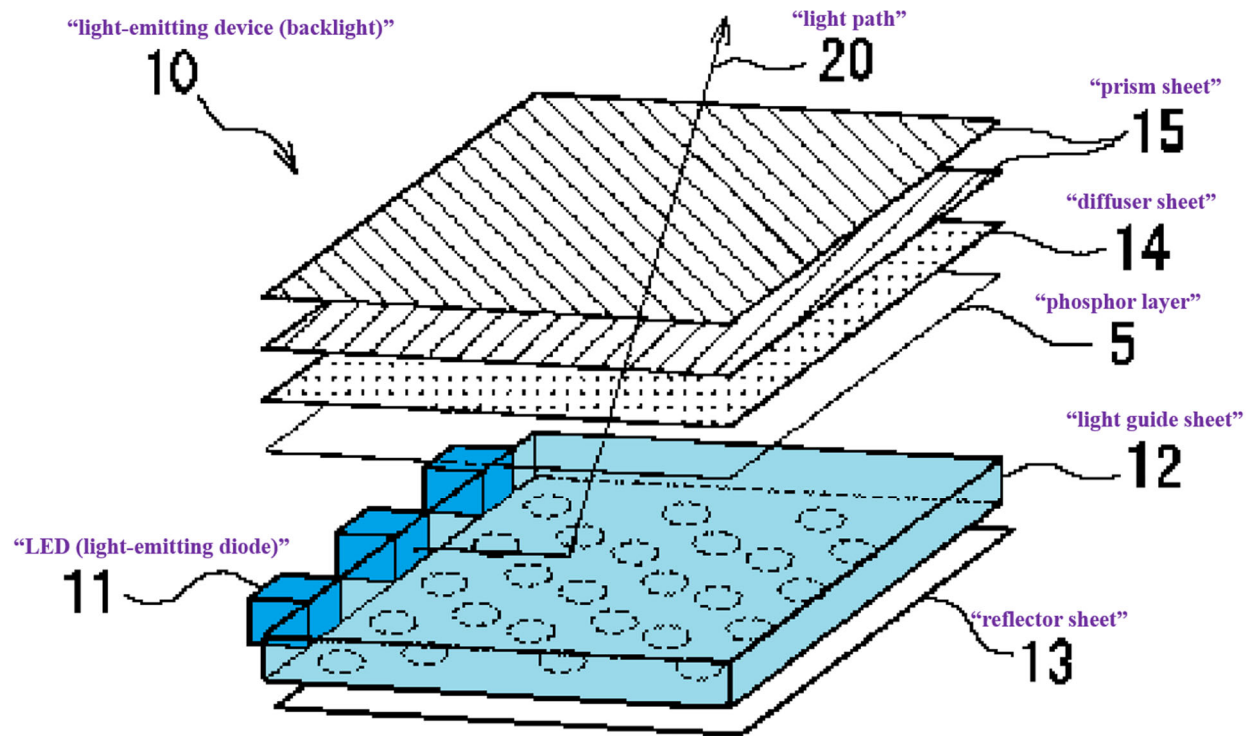
(EX1004-Asada at FIG. 2, 0040.)

98. Thus, Asada discloses this limitation.

[1B] “at least one light emitting module positioned so as to emit light incident on the light guide plate, wherein the at least one light emitting module comprises a plurality of light emitting diodes”

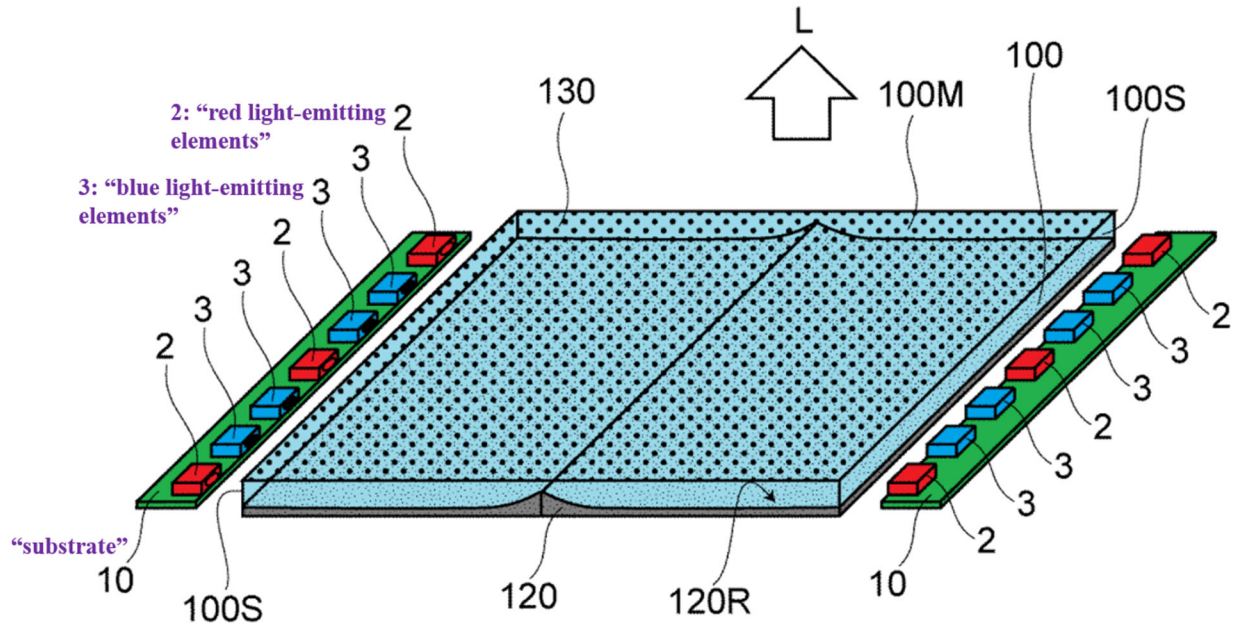
99. Asada in view of Kinoshita teaches this limitation.

100. Asada illustrates a device comprising three LEDs (11, highlighted dark blue), each emitting light incident on the light guide plate (12, highlighted light blue) as indicated by light path 20:



(EX1004-Asada at FIG. 2.)

101. Asada does not expressly state that the three LEDs in FIG. 2 are part of an LED module. However, it was obvious in view of Kinoshita to use a light emitting module comprising a plurality of LEDs on a substrate, including the conventional arrangement shown in Kinoshita's FIG. 1:

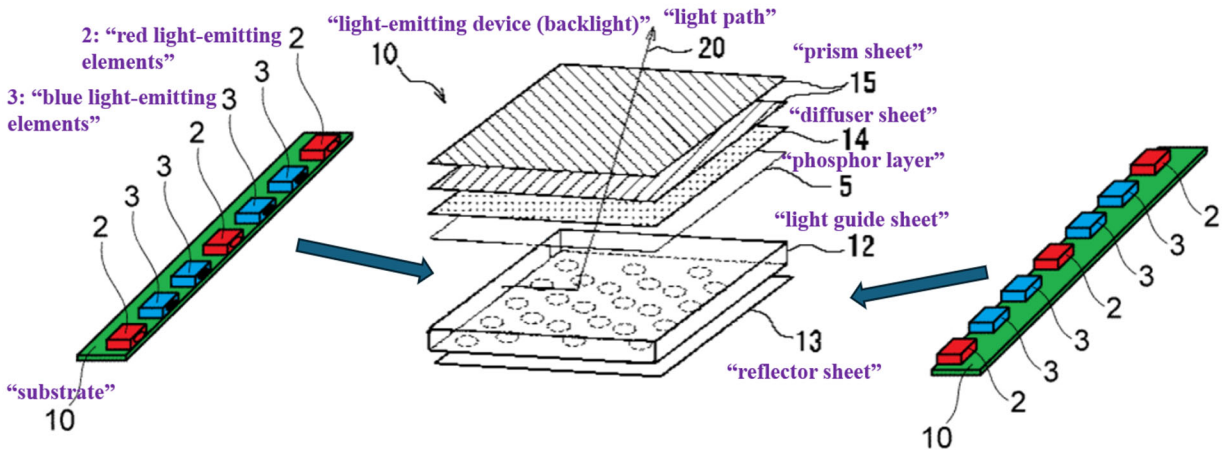


“FIG. 1 is a perspective view of the planar light-emitting device in the first embodiment of the present invention. This planar light-emitting device comprises a light guide plate 100 and red light-emitting elements 2 and blue light-emitting elements 3 disposed in close proximity to the side surfaces 100S of the plate. The red light-emitting elements 2 and blue light-emitting elements 3 are prepared and mounted on a substrate 10 so that their numbers are in a ratio of 1:2, for example. The light-emitting elements 2, 3, can be, for example, LEDs or LDs (laser diodes). In addition, their structure may be surface-emitting or edge-emitting. However, they are mounted on each substrate 10 so that their light emission is transverse to the main 20 surface of the substrate 10, that is, incident on the side surfaces 100S of the light guide plate 100.”

(EX1005-Kinoshita at FIG. 1, 0012-13.)

102. As I explain above in §VIII.A, it was obvious to utilize LED modules for

Asada's backlight device. One obvious way to combine the teachings of Asada and Kinoshita is illustrated below, where Kinoshita's LED modules replace Asada's LEDs in the device and provide edge-lighting for the light guide:



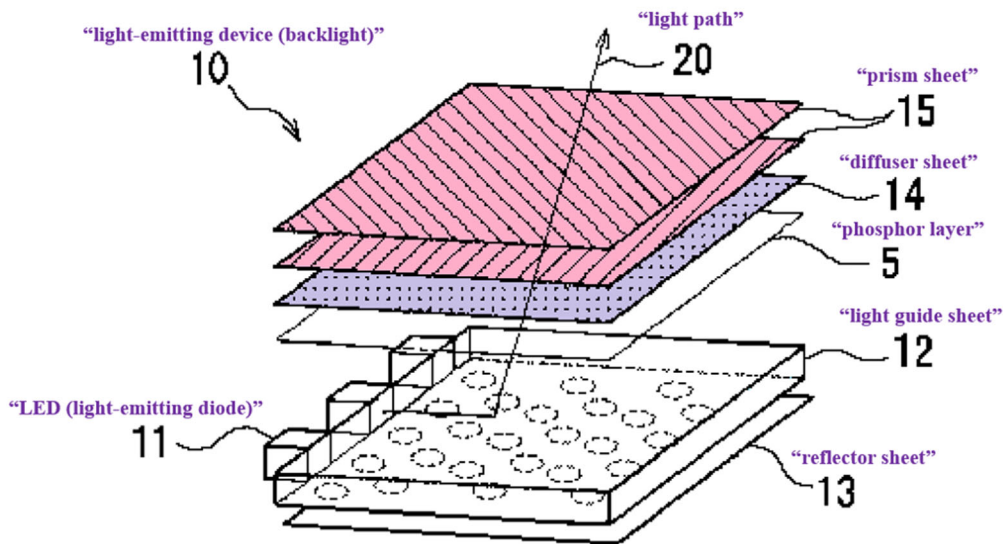
103. Thus, Asada in view of Kinoshita teaches this limitation.

[1C] “an optical sheet on a top surface of the light guide plate; and”

104. Asada discloses this limitation.

105. In the '778 patent, the word “on” includes “directly and indirectly” on.
(EX1001 at 1:59-63.)

106. Asada's FIG. 2 illustrates an optical sheet (comprising diffuser sheet 14 [highlighted purple] and prism sheet 15 [highlighted pink]) that is *indirectly* on a top surface of the light guide plate 12:



“The light-emitting device (backlight) 10 comprises an LED (light-emitting diode) 11, a light guide sheet (light guide member) 12, a reflector sheet 13, a diffuser sheet 14, and a prism sheet 15. The LED 11 comprises the same components as the light-emitting diode in the first embodiment shown in FIG. 1, except for the phosphor layer 5, and is disposed opposite the side surface of the light guide sheet 12. Reflector sheet 13 is disposed on the rear surface of the light guide sheet 12, and the diffuser sheet 14 and the prism sheet 15 are laminated on the surface of light guide sheet 12. The light emitted from the LED 11 enters light guide sheet 12, where some of it is reflected by the reflector sheet 13 and emitted from the surface of light guide sheet 12, passing through the diffuser sheet 14 and the prism sheet 15.”

(EX1004-Asada at FIG. 2, 0040.)

107. Per limitation 1E, discussed below, the “optical sheet” claimed in limitation 1C includes “a diffusion sheet and a prism sheet aligned with the diffusion

sheet.” Asada discloses such an arrangement, as shown above.

108. Thus, Asada discloses this limitation.

[1D] “a conversion sheet provided on a top surface of the optical sheet, wherein the conversion sheet converts a color of the light emitted by the at least one light emitting module to a target color”

109. Asada discloses, teaches, and suggests this limitation.

110. Asada’s phosphor layer 5 is a “conversion sheet” that converts light emitted by the light emitting module to a target color:

“The phosphor layer 5 *is in the form of a thin layer or sheet* and is adhered to the surface of the light guide sheet 12.”

(EX1004-Asada at 0041.)

111. Asada also explains:

“The phosphor particles 8 used in the light-emitting device of the present invention can be any phosphor particles capable of being excited by at least some of the light from the light-emitting element 3 and emitting light of the desired wavelength. For example, the phosphor particles 8 in a light-emitting device that emits white light when used with a blue light-emitting element 3 can contain a YAG-based phosphor activated with cerium as mentioned above. This phosphor material has excellent durability due to its garnet structure, and its excitation spectrum peak can be designed to be around 450 nm.”

(EX1004-Asada at 0023; *see id.* at 0020 (further describing YAG-based phosphor particles), 0027-38 (describing examples relative to generating a target “white” light

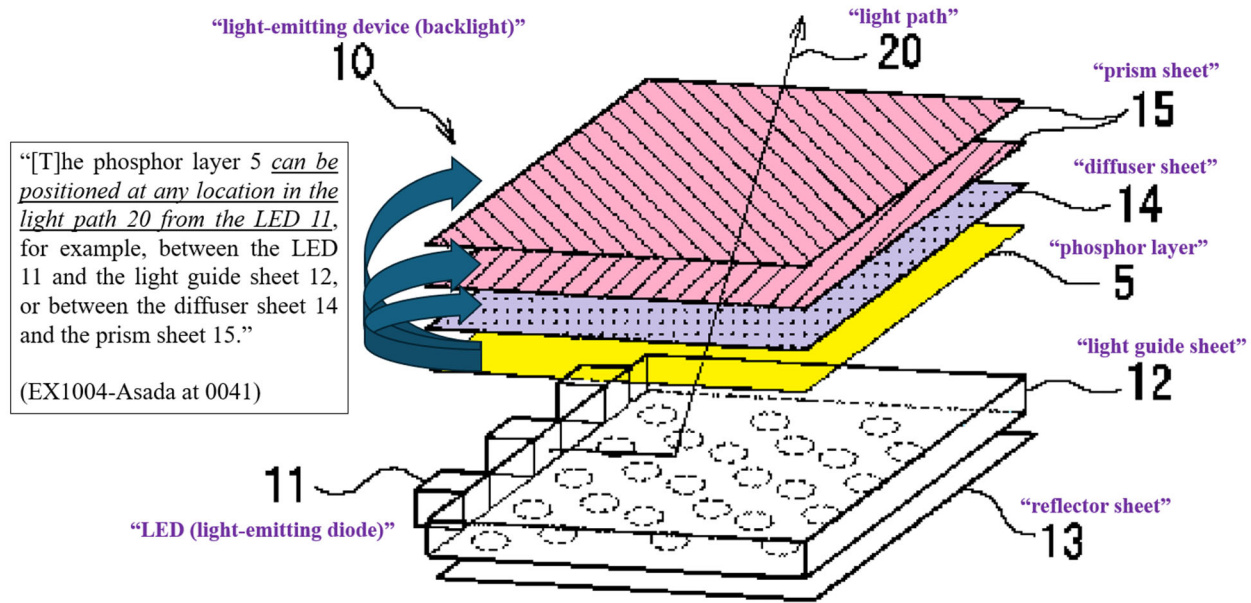
color from LEDs that emit light of another color, typically blue, as per paragraphs 0011-12).)

112. Asada's phosphor layer 5 in FIG. 2 is located between the light guide sheet 12 and the diffuser layer 14. (EX1004 at FIG. 2.) However, Asada expressly states that the phosphor layer 5 may be located "at *any location in the light path* from the LED:"

"In the present embodiment, the phosphor layer 5, which is densely packed with phosphor particles 8.... [T]he phosphor layer 5 can be positioned at any location in the light path 20 from the LED 11, for example, between the LED 11 and the light guide sheet 12, or between the diffuser sheet 14 and the prism sheet 15."

(EX1004-Asada at 0041.)

113. The excerpt above discloses, teaches, and suggests that Asada's phosphor layer 5 may be positioned anywhere in the light path, including on top of the prism sheet:



(EX1004-Asada at FIG. 2, 0041.)

114. A POSITA would have understood that Asada's phosphor layer converted light wavelengths, and the useful light in Asada's device was the light that follows the light path (20) in FIG. 2 and escapes the device. Thus, the phosphor layer would be expected to work for its intended purpose (converting light wavelengths) wherever it is placed within that path, as Asada states expressly. Given Asada's express teaching and the finite number of potential positions within Asada's device, it was also obvious to try each possible position for the phosphor layer within the light path.

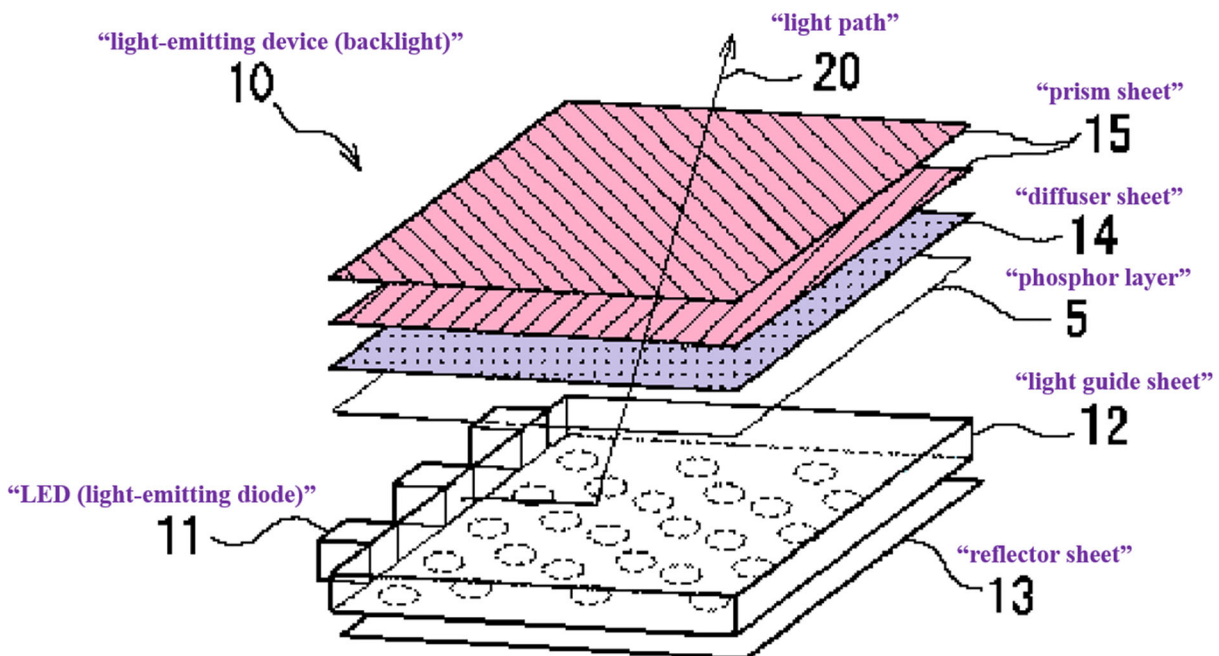
115. Thus, Asada discloses, teaches, and teaches this limitation.

[1E] "wherein the optical sheet includes a diffusion sheet and a prism sheet aligned with the diffusion sheet"

116. Asada discloses this limitation.

117. As I mentioned regarding limitation 1C, an “optical sheet” in the context of claim 1 includes two specific sheets: a diffusion sheet and a prism sheet.

118. Asada an “optical sheet” having a diffusion sheet (diffuser sheet 14 [highlighted purple]) and a prism sheet (prism sheet 15 [highlighted pink]) aligned with the diffusion sheet:



“The light-emitting device (backlight) 10 comprises an LED (light-emitting diode) 11, a light guide sheet (light guide member) 12, a reflector sheet 13, a diffuser sheet 14, and a prism sheet 15.”

(EX1004-Asada at FIG. 2, 0040.)

119. Thus, Asada discloses this limitation.

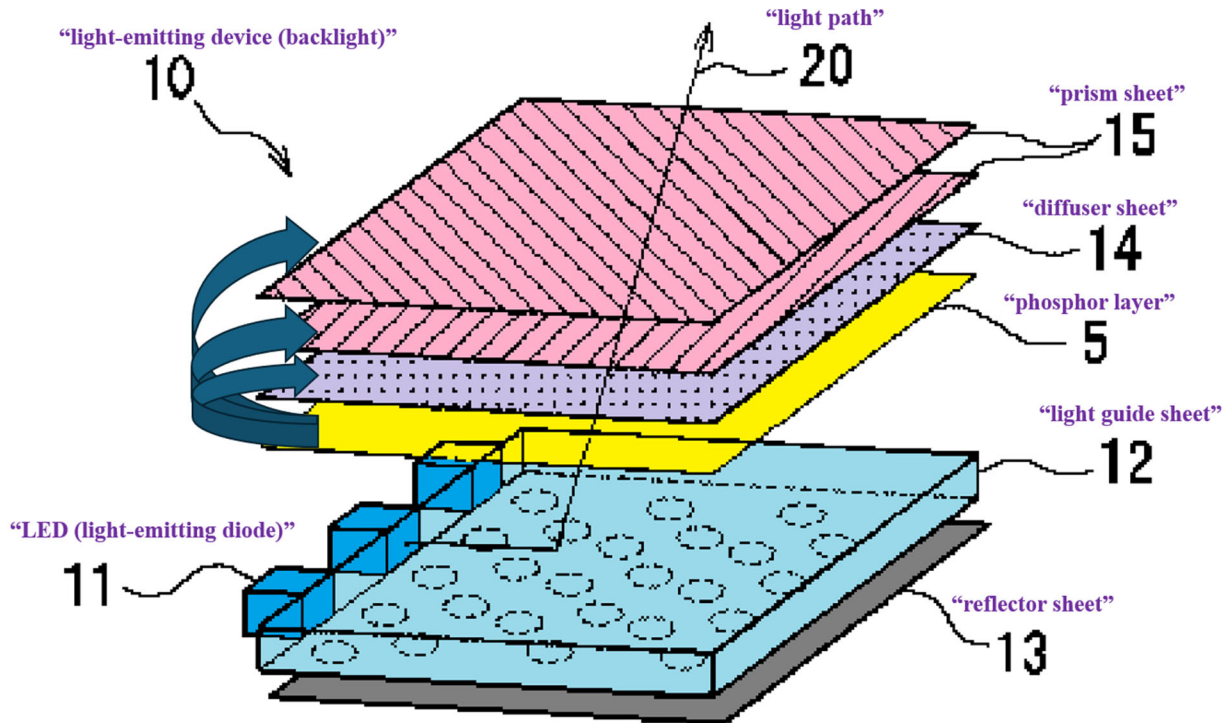
[1F] “wherein the optical sheet is disposed on the light guide plate and the conversion sheet such that the conversion sheet converts the color of the light passing through the diffusion sheet and the prism sheet”

120. Asada discloses this limitation.

121. This limitation requires the optical sheet to be disposed “on” the light guide plate” and “on” the conversion sheet,” implying the conversion sheet is located below the optical sheet, while limitation 1D requires the conversion sheet to be provided on “a top surface” of the optical sheet.

122. The specification also refers to several figures that show a conversion sheet disposed between a diffusion sheet and a prism sheet, as well as above an “optical sheet.” (*See* EX1001 at FIGS. 4-7.)

123. It is not clear from the claim language whether the conversion sheet must be on top of or below the optical sheet, but Asada discloses both options. As I explained above, Asada teaches all possible locations of a conversion sheet (phosphor layer 5), including on top of a light guide sheet (12), on top of a diffuser sheet (14) and on top of a prism sheet 15, including being located on top of the uppermost prism sheet 15:



(EX1004-Asada at 0040-41, FIG. 2.)

124. As I also note above regarding limitation 1D, Asada's conversion sheet (phosphor layer 5) also converts the color of light that passes through the layers of the optical sheet, as required by this limitation.

125. Thus, Asada teaches this limitation and Asada in view of Kinoshita renders obvious claim 1.

Claim 2: "The light source of claim 1, wherein the conversion sheet includes a fluorescent material having at least one color."

Claim 3: "The light source of claim 1, wherein the conversion sheet includes at least one of red, green, blue, or yellow fluorescent materials."

126. Asada discloses these limitations.

127. A fluorescent material according to the '778 patent includes materials that

convert emitted LED light to a different wavelength:

“The conversion sheet 145 shifts the color of the first light from the standard region A1 to the target region A2. More specifically, the conversion sheet 145 may shift the color coordinate of one or more of the points B1 C1, and D1 disposed within the standard region A1 of FIG. 2 to a position close to a center coordinate of the target region A2 having, for example, CIE_x=0.313 and CIE_y=0.329, which may be representative of the desired color of light, or target color, such as, for example, white light. The conversion sheet 145 may include at least one type of fluorescent material to convert a color rank of light emitted by the light emitting diode 112 to a target color rank.”

(EX1001 at 4:21-32.)

128. Phosphors are typically used for this purpose in LEDs, and a POSITA would have known that phosphors are a common type of fluorescent material.

129. Asada discloses phosphors, including phosphors that convert blue LED emissions into other colors:

“The present invention may also emit white light by combining a light-emitting element composed of a nitride semiconductor that emits blue light and a phosphor layer composed of phosphor particles that emit yellow-green to orange light, and mixing the blue light and the yellow-green to orange light together. In addition, the present invention may emit white light by using a phosphor layer composed of phosphor particles that emit light in the green range and the red range instead of a phosphor layer composed of phosphor particles that emit light in the yellow-green to orange range, and

mixing blue light with the green light and the red light. These simple configurations are able to realize a white light-emitting element with high luminance and high color rendering.”

(EX1004-Asada at 0011.)

130. Asada further discloses that its phosphors may be YAG-based phosphors:

“The phosphor particles 8 used in the light-emitting device of the present invention can be by any phosphor particles capable of being excited by at least some of the light from the light-emitting element 3 and emitting light of the desired wavelength. For example, the phosphor particles 8 in a light-emitting device that emits white light when used with a blue light-emitting element 3 can contain a YAG-based phosphor activated with cerium as mentioned above. This phosphor material has excellent durability due to its garnet structure, and its excitation spectrum peak can be designed to be around 450 nm.”

(EX1004-Asada at 0020.)

131. Asada also teaches that phosphor particles are used in Asada’s conversion sheet (phosphor layer 5):

“In the present embodiment, the phosphor layer 5, which is densely packed with phosphor particles 8, is disposed between the light guide sheet 12 and the diffuser sheet 14, rather than inside the LED (light emitting diode) 11. The phosphor layer 5 is in the form of a thin layer or sheet and is adhered to the surface of the light guide sheet 12. The phosphor layer 5 may also be formed integrally with the light guide sheet 12. In addition, the phosphor layer 5 can be positioned at any

location in the light path 20 from the LED 11, for example, between the LED 11 and the light guide sheet 12, or between the diffuser sheet 14 and the prism sheet 15.”

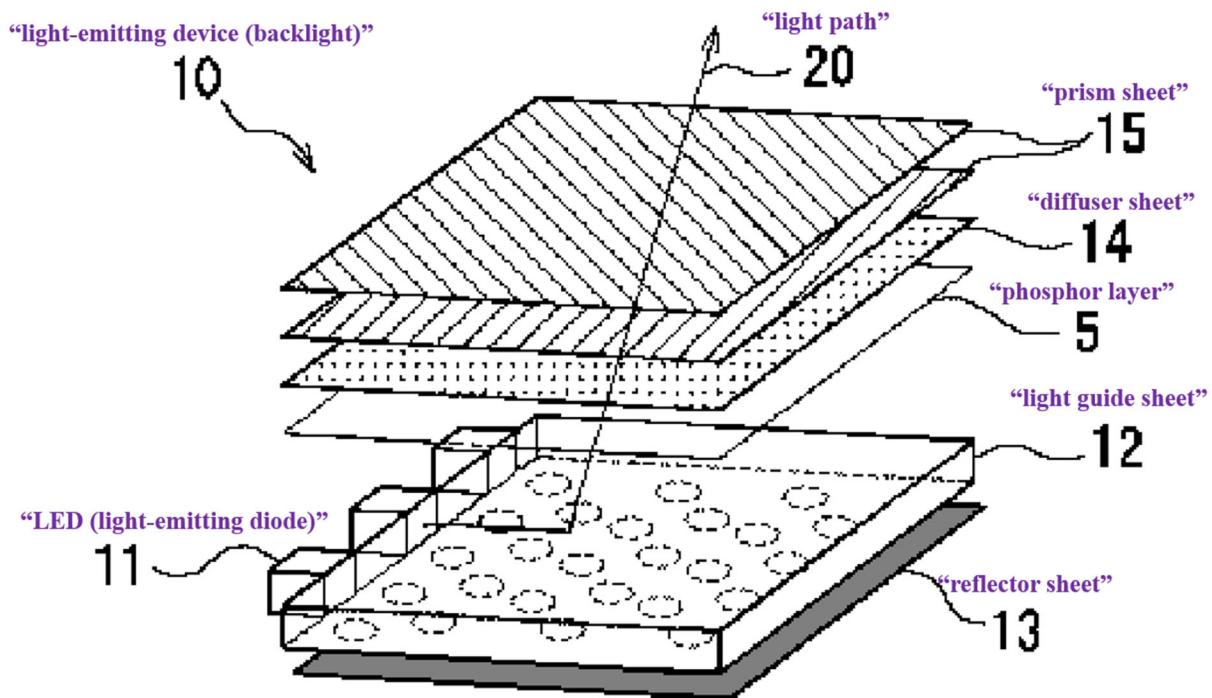
(EX1004-Asada at 0041.)

132. Thus, Asada discloses claims 2-3, and Asada in view of Kinoshita renders obvious claims 2-3.

Claim 4: “The light source of claim 1, further comprising a reflective plate positioned under the light guide plate.”

133. Asada discloses this limitation.

134. More particularly, Asada discloses “reflector sheet” 13 (highlighted gray):



“The light emitted from the LED 11 enters light guide sheet 12, where some of it is reflected by the reflector sheet 13 and emitted from the surface of light guide sheet 12, passing through the diffuser

sheet 14 and the prism sheet 15.”

(EX1004-Asada at FIG. 2, 0040.)

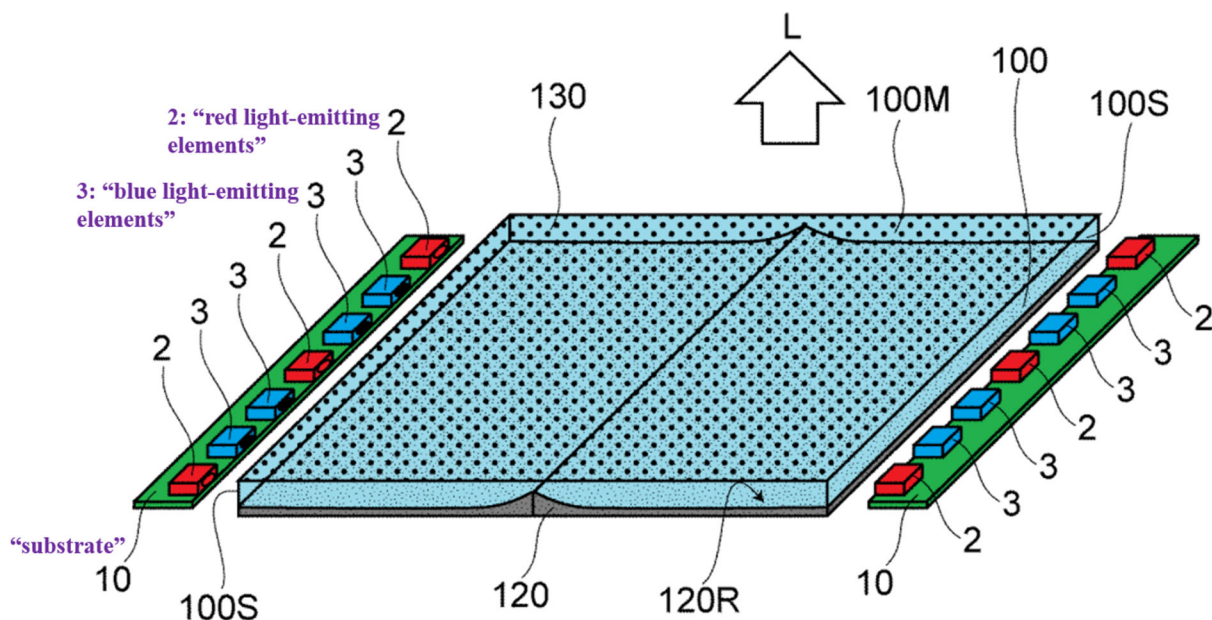
135. Thus, Asada discloses claim 4, and Asada in view of Kinoshita renders obvious claim 4.

Claim 5: “The light source of claim 1, wherein the at least one light emitting module comprises a first light emitting module positioned at a first side edge of the light guide plate, and a second light emitting module positioned at a second side edge of the light guide plate.”

Claim 6: “The light source of claim 5, wherein the first and second side edges of the light guide plate are opposite each other.”

136. Asada in view of Kinoshita teaches and suggests these limitations.

137. Kinoshita discloses LED-based modules with red and blue lights (highlighted accordingly), positioned on either side of the light guide plate (light blue):



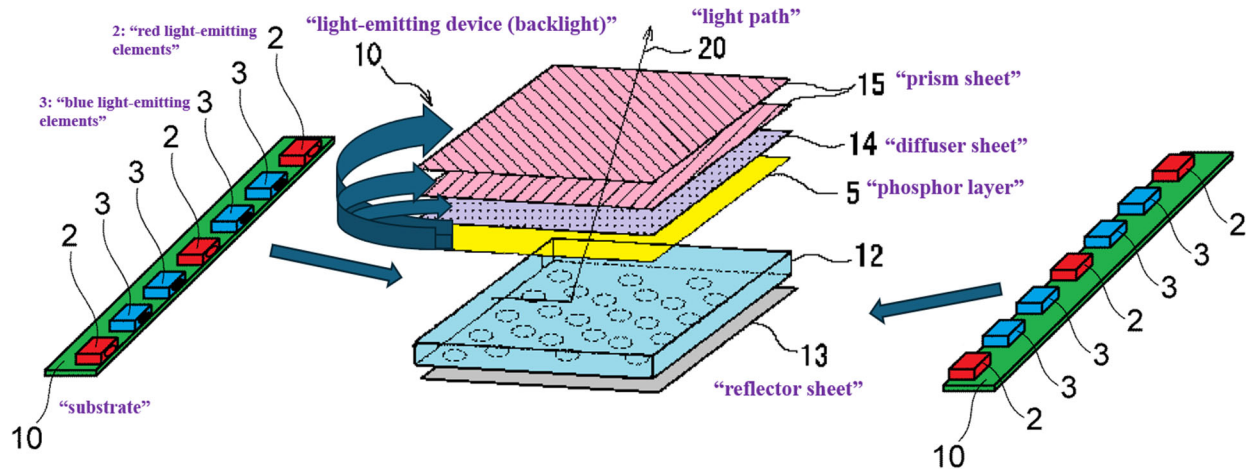
“FIG. 1 is a perspective view of the planar light-emitting device in

the first embodiment of the present invention. This planar light-emitting device comprises a light guide plate 100 and red light-emitting elements 2 and blue light-emitting elements 3 disposed in close proximity to the side surfaces 100S of the plate. The red light-emitting elements 2 and blue light-emitting elements 3 are prepared and mounted on a substrate 10 so that their numbers are in a ratio of 1:2, for example. The light-emitting elements 2, 3, can be, for example, LEDs or LDs (laser diodes). In addition, their structure may be surface-emitting or edge-emitting. However, they are mounted on each substrate 10 so that their light emission is transverse to the main 20 surface of the substrate 10, that is, incident on the side surfaces 100S of the light guide plate 100.”

(EX1005-Kinoshita at 0012-13 (emphasis added).)

138. A POSITA would have been motivated and found it obvious to modify Asada in view of Kinoshita to utilize multiple LED modules for Asada’s backlight device on the device’s sides, including on opposite sides of each other.

139. One typical way to combine the respective teachings of these references was to utilize Kinoshita’s LEDs substrates (modules) on opposite sides of Asada’s backlight device, as shown in Kinoshita’s FIG. 1, and illustrated below by way of an example combination with Asada’s FIG. 2:



140. Thus, Asada in view of Kinoshita teaches and renders obvious claims 5-6.

Claim 7: “The light source of claim 5, wherein the first and second side edges of the light guide plate are adjacent to each other.”

141. Asada in view of Kinoshita teaches this limitation.

142. As explained above, Kinoshita discloses LED modules located on opposite sides of a light guide plate 100. Kinoshita further discloses a lighting device in which lighting modules are provided on all four sides of the device (and, thus, adjacent sides):

“In this way, a[] light-emitting element array mounted on a substrate 10 is arranged for two side surfaces 100S of the light guide plate 100. However, the present invention is not limited to the configuration of the present embodiment. For example, a light-emitting element array can be arranged on only one side surface, or a light-emitting element array can be arranged on three or four side surfaces.”

(EX1005-Kinoshita at 0016.)

143. A POSITA would have understood that edge-lit backlight devices were

known to employ LED modules on between one and four sides of a four-sided light source.

144. Accordingly, a POSITA would have found it obvious to implement Asada in view of Kinoshita with two lighting modules on opposite sides of a light guide plate (including as shown above in §VIII.A) as well as with up to four lighting modules on all four sides of the light guide plate, including adjacent sides as required by claim 7. In addition to Kinoshita's express teaching, for example, Clary shows that such arrangements were a known implementation choice in the prior art;

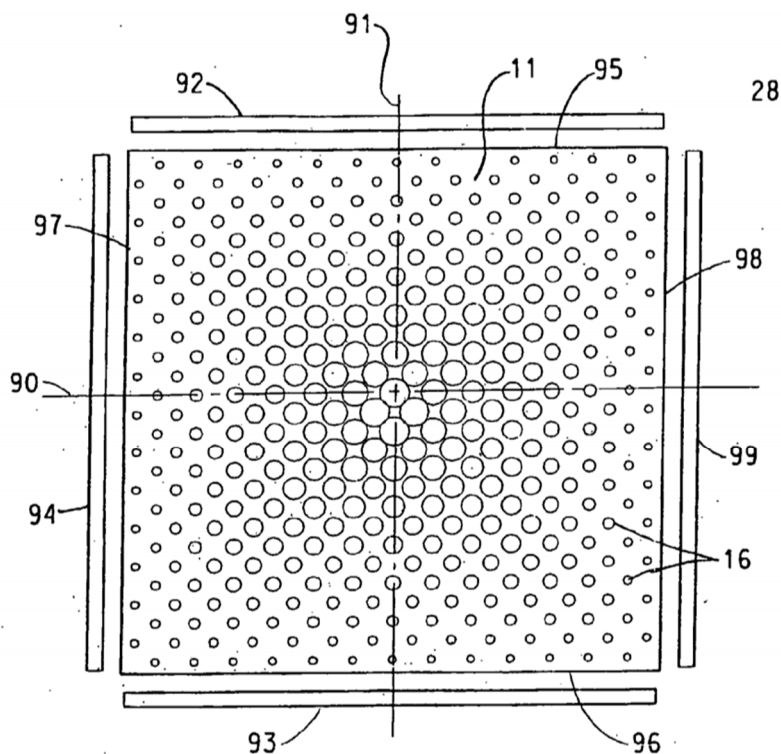


FIG. 9

(EX1008-Clary at FIG. 9, 0068.)

145. In view of Kinoshita, a POSITA would have been motivated and found it obvious to utilize LED modules on anywhere between 1 and all 4 sides of a light guide plate. For example, it was typical to use additional LEDs (such as LED modules on more than one side) for larger backlighting needs, including devices with larger panels or that required brighter light output.

146. Thus, Asada in view of Kinoshita discloses and renders obvious claim 7.

Claim 11: “The light source of claim 1, wherein the conversion sheet is configured to excite a portion of a first light emitted by the plurality of light emitting diodes so as to convert the portion of the first light to a second light, and to mix the first light and the second light so as to provide a third light having the target color.”

147. This claim does not make sense as written because the conversion sheet is excited by light, not the other way around.

148. To the extent this claim is interpreted to refer to the light emitted by the LEDs exciting the material in the conversion sheet, Asada discloses it.

149. Asada teaches that its conversion sheet (phosphor layer 5) is excited by blue light such that blue light is converted by the conversion sheet to yellow-green, orange, green, and/or red light (as well as green light), with the resulting light mixed together to provide a third light having the target color of white:

“The present invention may also emit white light by combining a light-emitting element composed of a nitride semiconductor that emits blue light and a phosphor layer composed of phosphor particles that emit yellow-green to orange light, and mixing the blue light and

the yellow-green to orange light together. In addition, *the present invention may emit white light by using a phosphor layer composed of phosphor particles that emit light in the green range and the red range* instead of a phosphor layer composed of phosphor particles that emit light in the yellow-green to orange range, and *mixing blue light with the green light and the red light*. These simple configurations are able to realize a white light-emitting element with high luminance and high color rendering.”

(EX1004-Asada at 0011.)

150. Thus, Asada discloses this limitation and Asada in view of Kinoshita renders obvious claim 11.

Claim 12: “The light source of claim 11, wherein the target color falls within a range in which x of CIE_x is between approximately 0.293 and 0.333, and y of CIE_y is between approximately 0.309 and 0.349.”

151. Asada in view of Kinoshita teaches and suggests this limitation.

152. The claimed ranges relate to the well-known 1931 CIE chromaticity space. The x,y coordinate ranges recited in claim 12 span the colors of white. The ’778 patent states: “ $CIE_x=0.313$ and $CIE_y=0.329$, which may be representative of the desired color of light, or target color, such as, for example, white light.” (EX1001 at 4:27-29.)

153. The ’778 patent’s mention of $x=0.313$, $y=0.329$ (also recited in claim 21) is simply the 6500K color temperature white point considered that of standard daylight white, commonly referred to as “D65.” Display technologies rely on color

space standards (like sRGB, Rec.709, Rec.2020), nearly all of which use D65 as the standard white point, which is functionally codified through color space definitions and calibration practices. Thus, the x,y coordinate ranges specified in Claim 12 are well known as "white" as would be known to a POSITA. Asada teaches that its LEDs should emit white light:

“It is an object of the present invention to solve this problem and provide a light-emitting device with no variation in light emission by converting light from the light-emitting element into white light via a phosphor layer filled with high-density phosphor particles”

(EX1004-Asada at 0008; *see also id.* at 00011-12, 0020, 0023, 0032-38.)

154. Kinoshita also teaches that its LEDs should emit white light:

“However, the concentration of the wavelength conversion material may be adjusted uniformly across the entire surface of the wavelength conversion sheet 130 so that the luminance of the green wavelength conversion light is five times greater than that of the blue excitation light. In this way, white light corresponding to human visual sensitivity can be obtained. If the luminance distribution in the in-plane direction of the main surface 100M is uneven, the in-plane distribution of the wavelength conversion material in the wavelength conversion sheet 130 may be adjusted accordingly.”

(EX1005-Kinoshita at 0024.)

155. A POSITA would have reasonably expected the white light emitted by the device of Asada, modified to include the LED modules of Kinoshita, to achieve a

“target color [that] falls within a range in which x of CIE_x is between approximately 0.293 and 0.333, and y of CIE_y is between approximately 0.309 and 0.349.” (See, e.g., EX1016-Liao at FIGS 1A, 0014 (identifying white as 0.313, 0.329 in the CIE color model); EX1018-Tasaki at 0041 & 0045 (disclosing emission of diffused white light at a particular luminance at coordinates CIE_x=0.3192, CIE_y=0.3375, which are within the claimed range); EX1010-Dejima at FIGS. 14-15 and 0006 (illustrating CIE color model figure depicting a “w” [white] label at the same location shown in EX1001; describing “PRIOR ART” FIG. 5 as illustrating the color reproduction range of a conventional white LED); EX1006-Ashdown at Figure 2 (illustrating the same “white” coordinate on XY chromaticity diagram); EX1012-Kurihara at FIGS. 20-21 (same as Dejima); EX1017-ANSI at Page 11 of 17 (2008 ANSI standard definition identifying “white” to more significant digits).) Typically, the CIE color model definition of white at 6500K is used, which is the case for the ’778 patent as well.

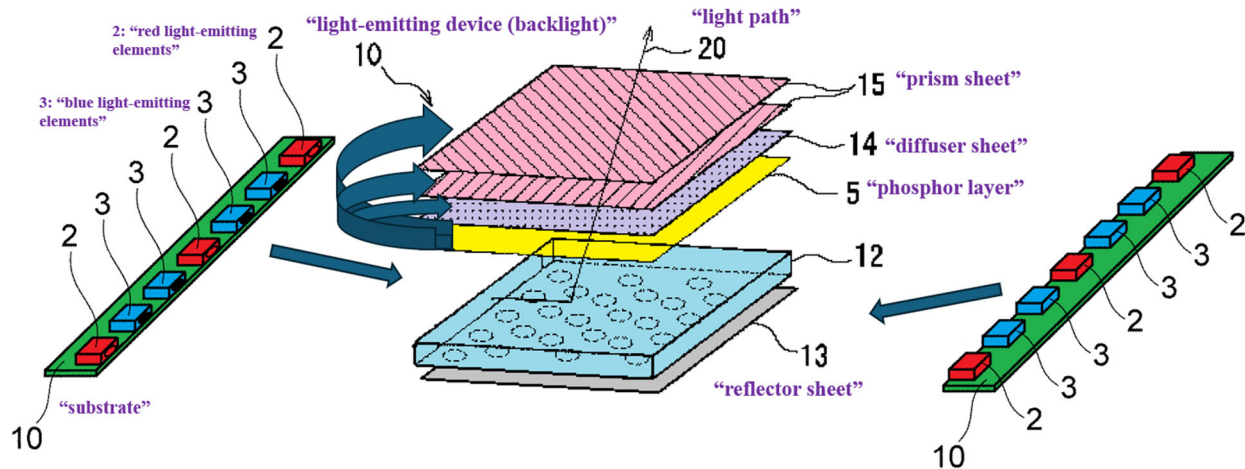
156. Thus, Asada in view of Kinoshita teaches and suggests this limitation and renders obvious claim 12.

Claim 13: “The light source of claim 12, wherein light emitted by the light guide plate has a color coordinate distribution that is outside of that of the target color.”

157. Asada in view of Kinoshita discloses this limitation.

158. Asada in view of Kinoshita discloses that at least blue light and red light

would be incident on the light guide plate, including as depicted in the illustration below:



159. As shown, the blue and red light emitted by the LEDs would only be converted to white light after passing through other layers, including the conversion layer (phosphor layer 5 shown in Asada's FIG. 2). (EX1004-Asada at 0011, 0023, 0040-41.)

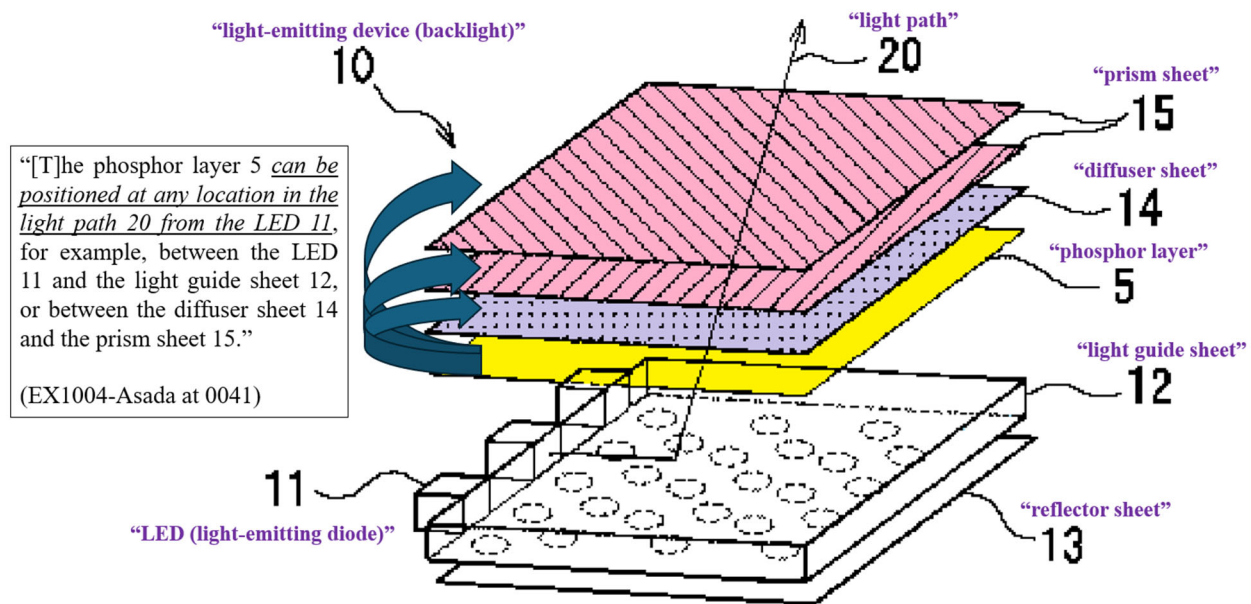
160. A POSITA would have understood that red and blue (and other non-white colors) have non-white color coordinate distributions. (See, e.g., EX1016-Liao at FIG. 1A, 0014; EX1006-Ashdown at Figure 2 (illustrating red, green, and blue colors at other coordinates); EX1010-Dejima at FIGS. 14-15 (same); EX1012-Kurihara at FIGS. 20-21 (same); EX1018-Tasaki at 0041 (disclosing examples of blue light emitting at $CIE_x=0.1275$, $CIE_y=0.0883$, which is a different color coordinate distribution than white light).)

161. Thus, Asada in view of Kinoshita discloses and renders obvious claim 13.

Claim 14: “The light source of claim 1, wherein a size of the conversion sheet is substantially equal to a size of the light guide plate.”

162. Asada discloses this limitation.

163. Asada’s FIG. 2 illustrates the conversion sheet (phosphor layer 5) as being substantially the same size of the light guide plate (light guide sheet 12):



(EX1004-Asada at FIG. 2; *see id.* at 0040 (disclosing lamination of diffuser sheet and prism sheet on the surface of the light guide sheet).)

164. Asada further discloses that “the phosphor layer 5...is disposed between the light guide sheet 12 and the diffuser sheet 14” and “is in the form of a thin layer or sheet and is adhered to the surface of the light guide sheet 12.” (*Id.* at 0041.)

165. A POSITA would have understood that Asada’s phosphor layer was “substantially equal to a size of the light guide plate” in order to ensure that all the light from the light guide plate is being processed by the phosphor layer—a phosphor

layer that was too small would not appropriately act on light incident from the light guide sheet 12, while a phosphor layer that was too large would unnecessarily waste material.

166. Accordingly, a POSITA would also reasonably expect and understand these layers to be substantially equal. The light is intended to pass through phosphor layer 5 as part of generating white light output, so the light guide sheet and associated layers would be expected to be the same size, as shown in Asada.

167. Thus, Asada in view of Kinoshita discloses and renders obvious claim 14.

Claim 23: [23Pre] “A light source”

168. Asada discloses this preamble. (See 1Pre.)

[23A] “a light guide plate”

169. Asada discloses this limitation. (See 1A.)

[23B] “at least one light emitting module positioned so as to emit light incident on the light guide plate, wherein the at least one light emitting module comprises a plurality of light emitting diodes”

170. Asada in view of Kinoshita teaches and suggests this limitation. (See 1B.)

[23C] “an optical sheet on a top surface of the light guide plate”

171. Asada discloses this limitation. (See 1C.)

[23D] “a conversion sheet provided on a top surface of the optical sheet, wherein the conversion sheet converts a color of the light emitted by the at least one light emitting module to a target color”

172. Asada discloses, teaches, and suggests this limitation. (See 1D.)

[23E] “a reflective plate positioned under the light guide plate”

173. Asada discloses this limitation. (See Claim 4.)

[23F] “wherein the light emitting module is positioned at a side edge of the light guide plate”

174. Asada in view of Kinoshita teaches and suggests this limitation. (See Claims 1, 5-6.)

[23G] “the optical sheet includes a diffusion sheet and a prism sheet on the diffusion sheet”

175. Asada discloses this limitation. (See 1E.)

[23H] “the conversion sheet is coated with a color coordinate material on an upper surface of the diffusion sheet such that the conversion sheet converts the color of the light diffusing by the diffusion sheet.”

176. Asada in view of Kinoshita teaches and suggests this limitation.

177. I note that this limitation requires the conversion sheet to be coated on an upper surface of the diffusion sheet, which has some tension with 23D (“a conversion sheet provided *on a top surface* of the optical sheet”) and limitation 23E (“the optical sheet includes a diffusion sheet and *a prism sheet on the diffusion sheet*”), so it is unclear how the conversion sheet is to be coated on the diffusion sheet. However, as I discuss above regarding limitation 1F, Asada discloses all potential location options for its phosphor layer 5, including being located on its light guide plate 12, on diffusion sheet 14, and on prism sheets 15.

178. Asada further teaches and suggests that the phosphor layer may be applied as a coating. Specifically, Asada states that the “phosphor layer 5 is in the form of a

thin layer or sheet” (EX1004-Asada at 0041.)

179. A POSITA would have known that it was common to achieve thin layers or sheets of phosphor materials in LED devices by using coating processes. Kinoshita teaches the same:

“The wavelength conversion sheet 130 can be formed, for example, using a resin. Specifically, the wavelength conversion sheet 130 may be formed by dispersing a phosphor in a resin and molding it into a sheet, or by coating a phosphor on the front surface (or back surface) of a transparent film. FIG. 2 shows views of the cross-sectional structure of various wavelength conversion sheets 130. Specifically, as shown in FIG. 2(a), a phosphor layer 130f can be formed on the surface of a film-like base material 130c, such as a resin, using, for example, a coating method. Also, as shown in FIG. 2(b), a phosphor may be dispersed in a base material 130 such as a resin. In addition, as shown in FIG. 2(c), sheets of translucent film 130c may be laminated, and a layer 130s containing a phosphor material may be coated or dispersed between these sheets. Furthermore, the wavelength conversion sheet 130 does not have to be an integral sheet, and may, for example, be a laminate of a plurality of sheets of film 130s, each containing a phosphor, as shown in FIG. 2(d). The wavelength conversion sheet 130 and the light guide plate 100 may be separate or formed as an integrated unit. Specifically, the wavelength conversion material may be coated on the main surface 100M of the light guide plate 100, or dispersed in some or all of the light guide plate 100.”

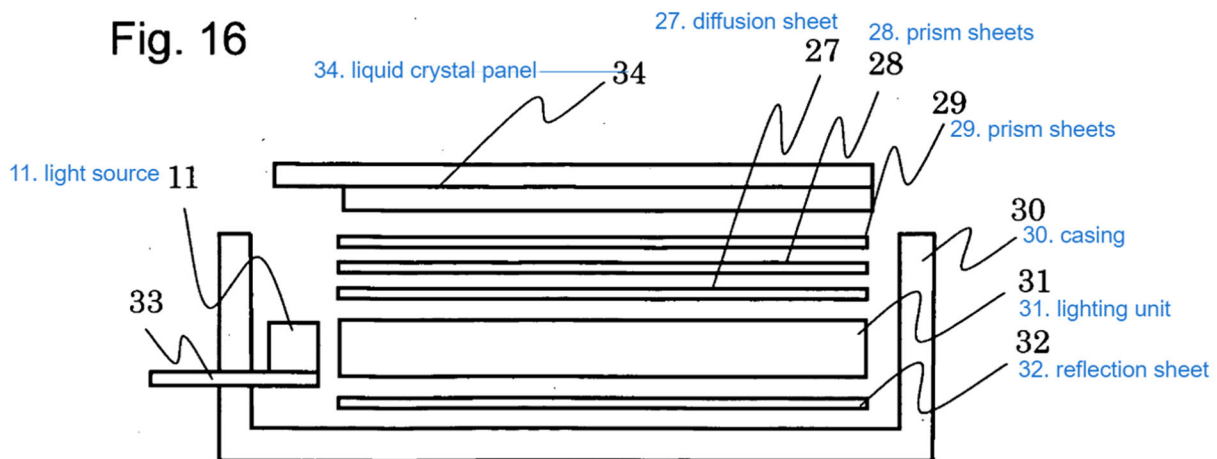
180. Thus, Asada in view of Kinoshita teaches and suggests this limitation and renders obvious claim 23.

IX. Ground 2: Asada in view of Kinoshita and Dejima discloses, teaches, and suggests every limitation of claim 15

A. Scope and content of the art, overview of the combination, motivation/rationale for the combination, and expectation of success

181. Asada in view of Kinoshita teaches an edge-lit lighting device. (*See* Ground 1.) A POSITA also would have been motivated and found it obvious to encase the lighting device taught by Asada and Kinoshita within Dejima's casing 30.

182. Dejima discloses an LCD having a casing 30 to which an edge-lit lighting unit is fixed:



(EX1010-Dejima at FIG. 16, 0068.)

183. Dejima's casing 30 covers/protects components of the LCD, including its

lighting unit 31, its edge light sources 11, and its reflector/diffusion/prism sheets (27-29, 32).

184. It was obvious to use Dejima's casing 30 to protect components of a light emitting display, including the LED modules and related layers taught by Asada and Kinoshita. This arrangement would have provided a predictable benefit by shielding the LEDs and light source layers from impact and related damage.

185. Applying Dejima's teachings to the Asada-Kinoshita device also merely required a simple modification: covering the light source with a casing, in order to protect the components of the light source including its LED modules, in the predictable manner provided by Dejima.

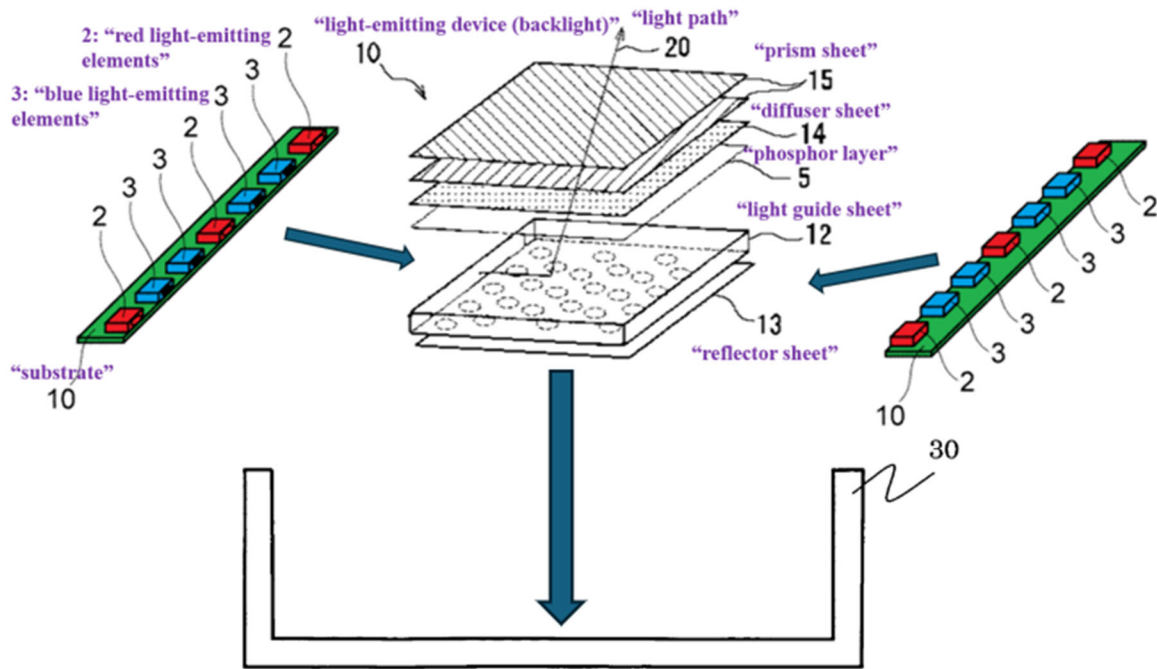
186. A POSITA also would have expected to succeed in making this combination. Asada, Kinoshita, and Dejima have related teachings, are in the same field as the '778 Patent, and describe similar edge-lit LED-based lighting devices. The use of covers like Dejima's casing was well known before the '778 patent, and it would have been straightforward to implement a Dejima casing with the Asada-Kinoshita lighting device, merely requiring ordinary skill to size and fit the casing to the device. Accordingly, A POSITA would thus have had no difficulty applying Dejima's teachings to the Asada-Kinoshita device.

B. The Challenged Claim

Claim 15: “The light source of claim 1, wherein the light guide plate, the at least one light emitting module and the conversion sheet are configured to be coupled to a cover having a receiving surface and side walls extending along an outer peripheral edge of the receiving surface, the side walls defining an open face of the cover so as to form a receiving space therein.”

187. Asada in view of Kinoshita and Dejima teaches and suggests this limitation.

188. Dejima’s FIG. 16 illustrates a casing for housing the components of an edge-lit lighting device like the device discussed in Ground 1 (Asada in view of Kinoshita). (EX1010-Dejima at 0068, FIG. 16; *see* Ground 1.) A POSITA would have found it obvious to couple and fix the device taught by Asada in view of Kinoshita, including its light guide plate, LED module(s), and conversion sheets, to Dejima’s casing 30, as illustrated below:



(EX1010-Dejima at 0068, FIG. 16.)

189. By fixing the device in Dejima's casing 30 as proposed, the device's light guide plate, light emitting module(s), and conversion sheet would be coupled to Dejima's cover.

190. Dejima's cover also has a receiving surface and side walls extending along an outer peripheral edge of the receiving surface, where the side walls define an open face of the cover so as to form a receiving space in the cover. The downward-pointing arrow shows that the device would be received in the receiving space when being coupled to casing 30.

191. Thus, Asada in view of Kinoshita and Dejima teaches and suggests this limitation and renders obvious claim 15.

X. Ground 3: Asada in view of Kinoshita and Ashdown discloses, teaches, and suggests every limitation of claims 8-10 and 24-26

A. Scope and content of the art, overview of the combination, motivation/rationale for the combination, and expectation of success

192. Asada in view of Kinoshita teach the use of light emitting modules that emit various colors of light. (*See* Ground 1.) Ashdown discloses ways of mitigating the impact that LEDs of different “ranks” have on light output for a given device, which in turn reduces the need to carefully “bin” LEDs within a given color. The ’778 patent’s references to LED “ranks” relates to the concept of binning in that one would typically incur waste or sorting expense to separate LEDs of different “ranks” into different “bins.” (EX1001 at 2:61-3:19, 5:14-17.)

193. A POSITA would have been motivated and found it obvious to apply Ashdown’s teachings regarding LED binning to the teachings of Asada and Kinoshita. Ashdown refers to earlier publications and explains that edge-lit backlighting systems do not require the same careful color binning as back-lit backlighting systems:

“LED backlighting system designs wherein the LEDs are mounted directly behind the LCD panel necessarily require very careful color binning. However, designs wherein the LEDs provide illumination for an edge-lit diffuser only requires that the mixed color of the LEDs meet the display primary chromaticity requirements. As noted by Folkerts et al, this allows a wider range [of] color bins to be employed.”

194. Asada and Kinoshita disclose edge-lit backlighting systems, and a POSITA would have understood from Ashdown that careful binning was not necessary when employing the Kinoshita LED modules with the Asada lighting device such that LEDs of different “ranks” may ordinarily be used together. (EX1006-Ashdown at 63371A-5–A-6.)

195. Ashdown further teaches a “six-color” binning technique that follows a brief discussion of “Grassman’s three laws of color additivity:”

“These laws form the basis of our ‘six-color’ binning solution. Referring to Figure 2, it is sufficient to choose at least two LEDs of each color whose chromaticities result in a hexagonal color gamut that subsumes the display phosphor chromaticities. In accordance with Grassman’s second law, it is evident that the luminous flux output from two or more LEDs with the same nominal color (red, green, or blue) can be blended to produce a composite third color whose saturation is approximately equal to that of the individual LEDs.”

(EX1006-Ashdown at 63371A-6.)

196. As one example, Ashdown teaches that pairs of LEDs having different color coordinates (e.g., two blue, two green, and two red LEDs) may be used together without careful binning so long as they form a hexagonal color gamut around a display phosphor chromaticity:

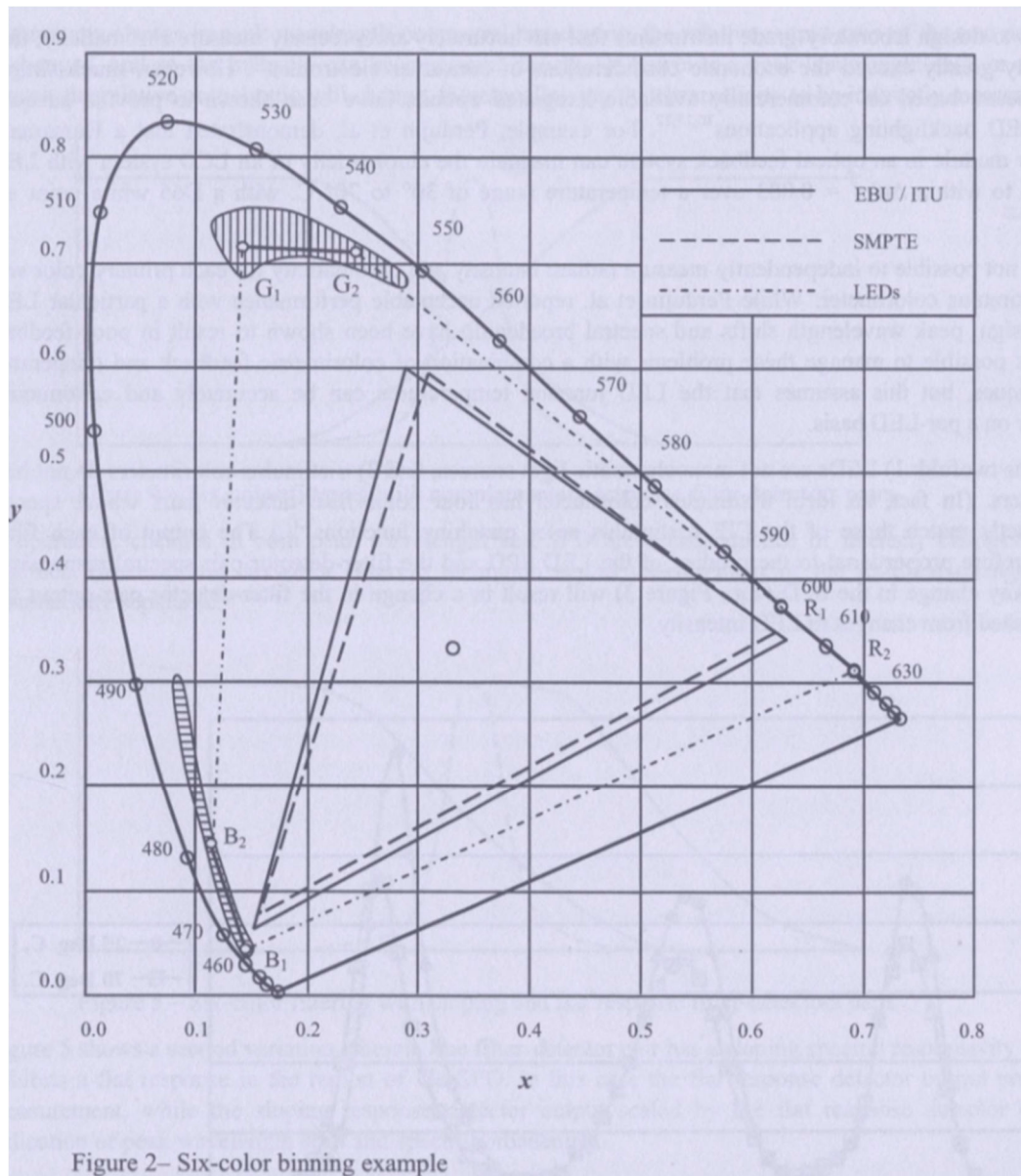


Figure 2— Six-color binning example

(EX1006-Ashdown at Figure 2; 63371A-6–A-7.)

197. Thus, Ashdown teaches that an even wider range of color bins may be used for edge-lit devices. Ashdown thereby discloses an obvious modification of Asada in view of Kinoshita that allows a larger portion of LEDs of a given color to be used within the device without having to use LEDs of the same “rank” from the same bin. For reference, the term “bin” refers to a conventional process in LED production

198. In the manufacture of LEDs, the peak emission wavelength can vary across a single wafer, between wafers, and from production lot to lot. These variations are primarily due to factors such as reactor control precision, thermal profile uniformity, and equipment aging. For example, during the relevant time period, the typical peak wavelength distribution for blue LEDs might span a 20 nm range—from 440 nm to 460 nm.

199. However, many applications—particularly those requiring tight color control, such as display backlighting—demand much narrower wavelength tolerances. A common tolerance window is ± 2.5 nm, meaning the acceptable peak wavelength range for a given application might only be 5 nm wide. To meet this requirement, manufacturers sort LEDs into “color bins,” each representing a narrow sub-range of the broader manufacturing distribution. For instance, bins might include 440–445 nm, 445–450 nm, 450–455 nm, and 455–460 nm.

200. When an application restricts itself to a single color bin, it can only utilize a small fraction of the total production output, which complicates procurement, increases cost, and reduces manufacturing yield efficiency. The innovation discussed by Ashdown—specifically, mixing LEDs from different color bins to achieve a desired composite color point—alleviated these supply chain challenges. By allowing multiple bins to be used in a single product, this approach significantly

reduced cost and improved availability for color-sensitive applications such as LCD backlighting.

201. As one example, Ashdown teaches and suggests that different bins of blue LEDs may be used in Asada in view of Kinoshita's LED modules. This binning flexibility improves manufacturability and cost while still achieving the same desired color output from the device as a whole.

202. Ashdown also provides the basic motivation and rationale to apply its teachings: reducing the need to carefully bin individual LEDs, thereby reducing overall system cost. A POSITA would have recognized that this combination loosened the requirements for producing a particular device, thereby simplifying or eliminating the task of carefully separating LEDs.

203. A POSITA also would have expected to succeed in making this combination. Asada, Kinoshita, and Ashdown have related teachings, are in the same field as the '778 Patent, and describe similar edge-lit LED-based lighting devices.

204. Ashdown's teachings also show that a POSITA would have succeeded in making these combinations, because by using a mix of LEDs as suggested by Ashdown the production process would be simplified through the use of less stringent binning processes. (EX1006-Ashdown at 63371A-7, Figure 2.)

B. The Challenged Claims

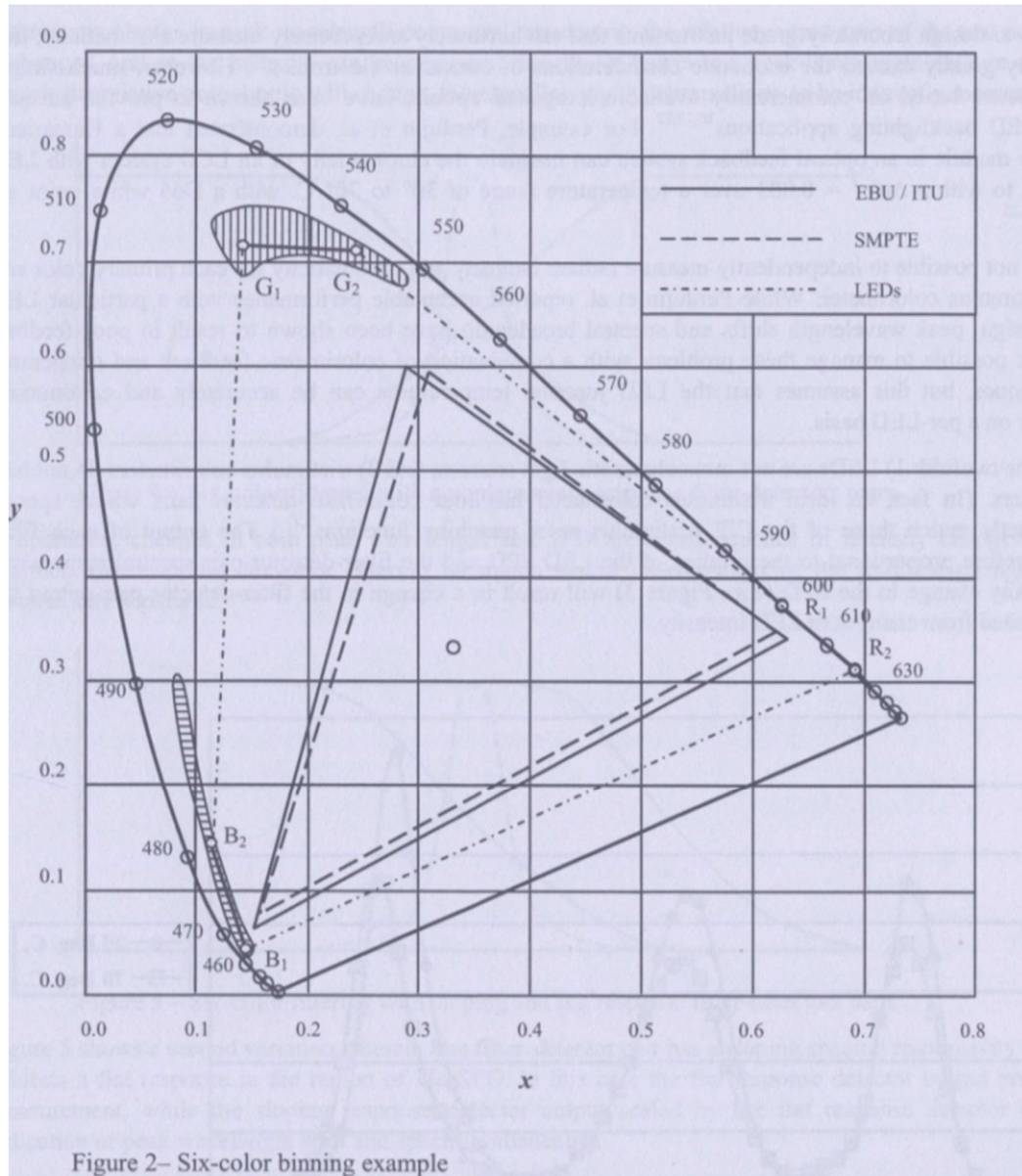
Claim 8: “The light source of claim 1, wherein at least two of the plurality of light emitting diodes have different color coordinate distributions within a same color spectrum.”

205. Asada in view of Kinoshita and Ashdown teaches and suggests this limitation.

206. Ashdown teaches that LEDs of different color coordinate distributions without requiring any modification, because edge-lit devices “allow[] a wider range [of] color bins to be employed.” (EX1006-Ashdown at 63371A-5–A-6.)

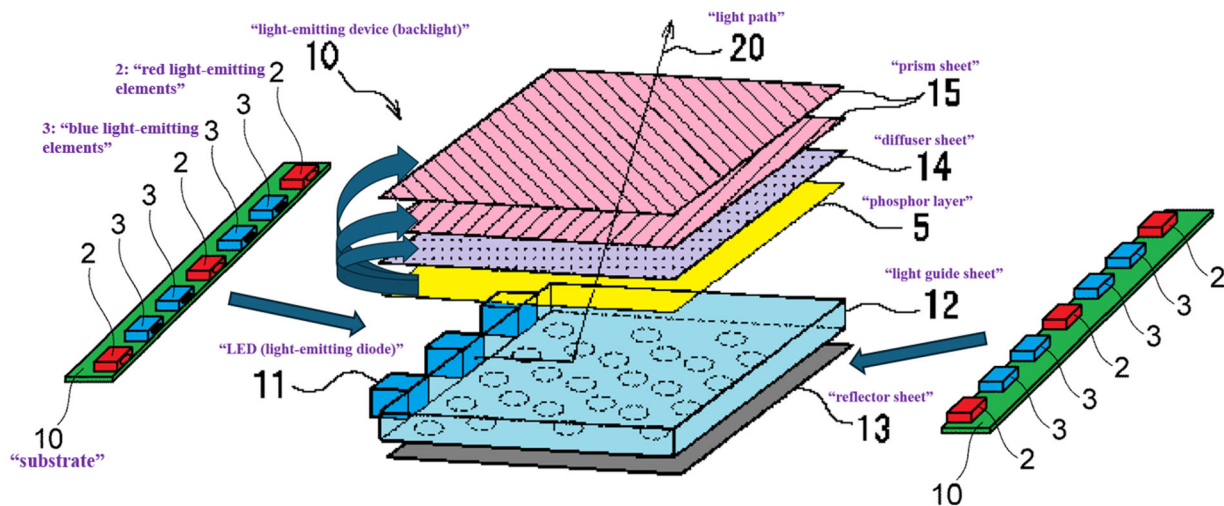
207. Ashdown teaches that an even wider range of color coordinate distributions within the same color may be used if desired by using at least two LEDs of each color (red, green, blue). (EX1006-Ashdown at 63371A-6–A-7, FIG. 2.)

208. For example, Ashdown teaches that at least two blue LEDs B1 and B2 may be used together, despite having different color coordinates:



(EX1006-Ashdown at 63371A-7, Figure 2.)

209. Adopting Ashdown's teaching was a routine, predictable, and obvious way to modify the Asada-Kinoshita device, and a POSITA would have implemented this teaching to enable the use of more LEDs without requiring careful binning. For example, in the illustrated combination below, green LEDs would also be used to take advantage of Ashdown's teachings and reduce the binning requirements:



210. As discussed above, Ashdown further teaches that the LED modules may add green LEDs and use “six-color” binning, thereby employing green, red, and blue LEDs having different color coordinates to achieve a desired white color output.

211. Thus, Asada in view of Kinoshita and Ashdown teaches and suggests this limitation and renders obvious claim 8.

Claim 9: “The light source of claim 1, wherein at least two of the light emitting diodes comprise a plurality of light emitting diode chips emitting light of multi ranks with a wavelength difference within a blue color spectrum therein, respectively”

212. Asada in view of Kinoshita and Ashdown teaches and suggests this limitation for the same reasons as claim 8.

213. As discussed regarding claim 8, Asada in view of Kinoshita may use blue LEDs emitting light of multi ranks within the blue spectrum given Ashdown’s teaching that edge-lit devices (like Asada and Kinoshita) allow a wider range of color bins to be employed, and in further view of Ashdown’s “six-color” binning teaching

214. Thus, Asada in view of Kinoshita and Ashdown teaches and suggests this limitation and renders obvious claim 9.

Claim 10: “The light source of claim 9, wherein the light plurality of emitting diode chips comprise at least one of a blue light emitting diode chip, a green light emitting diode chip, a yellow light emitting diode chip, an amber light emitting diode chip, or a blue-green light emitting diode chip.”

215. Asada in view of Kinoshita and Ashdown teaches and suggests this limitation.

216. The phrase “the light plurality of emitting diode chips...” does not make any sense. To the extent this claim is interpreted to refer to “the plurality of light emitting diode chips,” the claim is rendered obvious by Asada in view of Kinoshita and Ashdown for the reasons discussed above regarding claims 8-9. In particular, the plurality of LEDs comprise blue LED chips and green LED chips.

217. Thus, Asada in view of Kinoshita and Ashdown teaches and suggests this limitation and renders obvious claim 10.

Claim 24: “The light source of claim 23, wherein at least two of the light emitting diodes comprise a plurality of light emitting diode chips emitted light of multi ranks with a wavelength difference from each other within a blue color spectrum therein, respectively”

218. Asada in view of Kinoshita and Ashdown teaches and suggests this limitation. (See claims 8-9.)

219. Thus, Asada in view of Kinoshita and Ashdown teaches and suggests this

limitation and renders obvious claim 24.

Claim 25: “The light source of claim 24, wherein the conversion sheet is configured to excite a portion of a first light emitted by the plurality of light emitting diodes so as to convert the portion of the first light to a second light, and to mix the first light and the second light so as to provide a third light having the target color, wherein the target color falls within a range in which x of CIE_x is between approximately 0.293 and 0.333, and y of CIE_y is between approximately 0.309 and 0.349”

220. Asada in view of Kinoshita teaches and suggests this limitation. (See claim 12.)

221. Thus, Asada in view of Kinoshita and Ashdown renders obvious claim 25.

Claim 26: “The light source of claim 23, wherein at least two of the plurality of light emitting diodes have different color coordinate distributions within a same blue color spectrum”

222. Asada in view of Kinoshita and Ashdown teaches and suggests this limitation. (See claims 8-9.)

223. Thus, Asada in view of Kinoshita and Ashdown discloses and renders obvious claim 26.

XI. Ground 4: Asada in view of Kinoshita and Cho discloses, teaches, and suggests every limitation of claims 20-22

A. Scope and content of the art, overview of the combination, motivation/rationale for the combination, and expectation of success

224. Asada in view of Kinoshita teach the use of lighting emitting modules that emit various colors of light. (See Ground 1.) Neither Asada nor Kinoshita disclose covers for LED panels, but it was obvious to use a cover, as shown in Cho.

225. Cho discloses LCD panels that include a backlight to generate white light

(as shown in FIG. 3), including an edge-lit design having a cover over an LED module (as shown in FIG. 2):

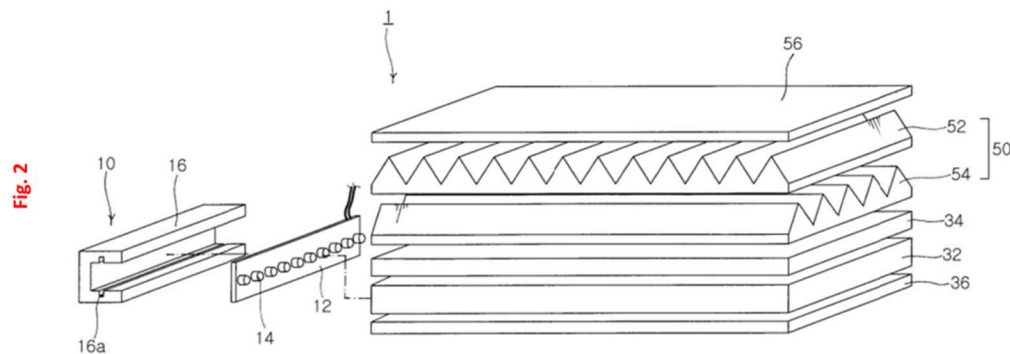
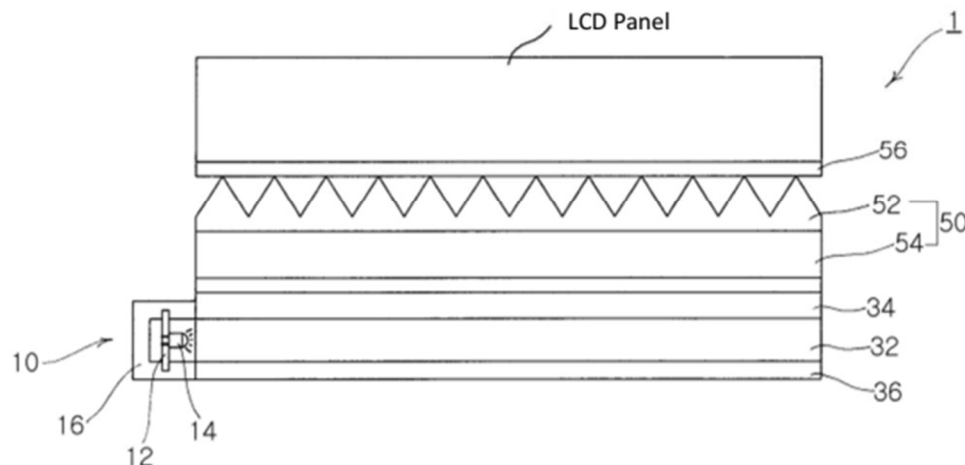


Fig. 3



(EX1007-Cho at FIGS. 2, 3; *id.* at 5, 6.)

226. A POSITA would have been motivated and found it obvious to implement Asada and Kinoshita in further view of Cho's teachings regarding a cover and LED panel. Asada and Kinoshita disclose edge-lit backlights for use in displays such as LCD panels. (*See, e.g.*, EX1004-Asada at 0001; EX1005-Kinoshita at 0001-02 (describing the present invention as intended for backlighting in LCD displays).)

227. Cho further discloses “a backlight module for an LCD (Liquid Crystal Display) using LEDs,” including “an LCD backlight module using LEDs having excellent energy efficiency and long lifespan.” (EX1007-Cho at 1.) Cho’s backlight module is combined with a protective cover for the LED modules and an LCD panel, as shown above in FIG. 3. Thus, Cho discloses an obvious modification of Asada in view of Kinoshita that uses a cover to protect the LEDs. This type of design was in common usage, as illustrated above.

228. Cho’s LED module cover would have improved Asada in view of Kinoshita and would have merely required a routine improvement (a protective cover for LEDs and LCD panel for display), which was readily improved and predictably would have been used with a cover.

229. Additionally, using Kinoshita’s known modules in Asada’s device merely required simple and routine additions (adding a cover and an LCD panel) to perform the intended function (protecting LEDs in an edge-lit backlighting device for a display) in a known and predictable manner.

230. A POSITA also would have expected to succeed in making this combination, which merely required combining an edge-lit backlighting device with a conventional protective component.

B. The Challenged Claims

Claim 20: [20Pre] “A display device, comprising:”

231. Asada in view of Kinoshita and Cho teaches and suggests this preamble.

232. Claim 20 requires “a cover” and a “display panel,” which were not required by claims 1 and 23 (analyzed above).

233. Asada describes its FIG. 2 as a “backlight” device, but does not state that the backlight device is used in a display that has a cover and display panel. This was a well-known use for a backlighting device in view of Cho.

234. Cho discloses an edge-emitting backlight module like those in Asada and Kinoshita that provides backlighting for an LCD display. (EX1007-Cho at Abstract (“The present invention relates to a backlight module for an LCD (Liquid Crystal Display), using LEDs...”), 4 (teaching that LCD displays were a conventional display device and explaining that “it is general to provide a backlight consisting of a light source that generates light and a light guide plate on the back surface of the LCD panel. At this time, the backlight generates white light so that the color of the image implemented by the LCD panel can be reproduced close to the actual color.”))

235. Thus, Asada in view of Kinoshita and Cho teaches and suggests the preamble.

[20A] “a cover;”

236. Asada in view of Kinoshita and Cho teaches and suggests this limitation

237. Asada in view of Kinoshita discloses an edge-emitting LED backlight that

uses LED modules. (See Ground 1, claim 1.) Cho further provides a cover 16 in which an LED module 12 is fixed:

“Meanwhile, the substrate 12 on which a plurality of LEDs 14 are mounted as described above is inserted and fixed within the light source cover 16. At this time, the light source cover 16 may have a rectangular pipe shape with one side open, and coupling grooves 16a are formed on its inner surface in the longitudinal direction of the light source cover 16, so that the substrate 12 is inserted and fixed into the coupling grooves 16a.”

(EX1007-Cho at 5, FIGS. 2-3.)

238. As discussed above, it would have been routine to fix the components of a lighting device like Asada’s within a cover.

239. Thus, Asada in view of Kinoshita and Cho discloses and renders obvious this limitation.

[20B] “a light emitting module provided on the cover, the light emitting module comprising a plurality of light emitting diodes;

240. Asada in view of Kinoshita and Cho teaches and suggests this limitation.

241. Asada in view of Kinoshita discloses and renders obvious a light emitting module comprising a plurality of LEDs. (See 1B.)

242. When implemented in further view of Cho, the light emitting modules would be provided on a cover, as disclosed in Cho. (EX1007-Cho at FIGS. 2-3, 5 (“[T]he substrate 12 on which a plurality of LEDs 14 are mounted as described above is inserted and fixed within the light source cover 16.”); see 20A.)

243. It was obvious to implement Asada in view of Kinoshita and Cho's cover such that the lighting module of the Asada-Kinoshita lighting device was provided on a cover. (*See* §XI.A.)

244. Thus, Asada in view of Kinoshita and Cho teaches and suggests this limitation.

[20C] "a light guide plate provided at a side of the light emitting module;"

245. Asada in view of Kinoshita teaches and suggests this limitation. (*See* 1A.)

[20D] "an optical sheet provided on the light guide plate, the optical sheet including a diffusion sheet and a prism sheet aligned with the diffusion sheet;"

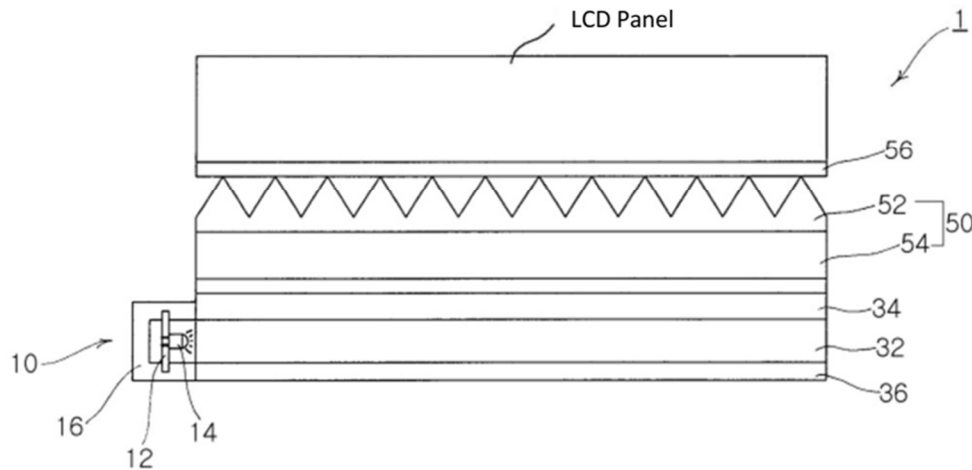
246. Asada in view of Kinoshita teaches and suggests this limitation. (*See* 1C, 1E.)

[20E] "a display panel provided on the optical sheet; and"

247. Asada in view of Kinoshita and Cho teaches and suggests this limitation.

248. Cho discloses an LCD display panel on top of optical sheet elements, including diffusion plate 34 and prism 50:

Fig. 3



“As shown in FIG. 3, a prism 50 is disposed on the upper surface of the diffusion plate 34 disposed on the upper surface of the light guide plate 32, and the prism 50 guides light from the diffusion plate 34 into a predetermined area (image formation area) of *the LCD panel*.”

(EX1007-Cho at FIG. 3, 6; *see id.* (“A protective sheet 56 for protecting the prism 50 may be disposed on the upper surface of the prism 50.”).)

249. Thus, Cho discloses the claimed arrangement in two ways, because the ’778 patent treats the LCD panel in the above figure as being “on” the optical sheet elements and, even if that were not the case, protective sheet 56 is merely an optional sheet. (EX1001 at 1:57-63 (noting that whether one layer/sheet is considered “on” another layer/sheet includes all meanings of “directly” and “indirectly”); EX1007-Cho at 6 (stating “the prism 50 may be disposed...”)).

250. A POSITA would have understood this to be a known and obvious arrangement of a display panel on an optical sheet in a display device. Accordingly,

a POSITA would have been motivated and found it obvious to use a display panel on top of the Asada-Kinoshita device, which would result in Cho's LCD panel disposed on top of the conversion layer (Asada's phosphor layer 5) and optical sheet, per limitation 20D (above) and 20F (below).

251. Thus, Asada in view of Kinoshita and Cho discloses this limitation.

[20F] “a conversion layer provided between the optical sheet and the display panel, wherein the conversion layer converts a first color of light emitted by the light guide plate to a target color, and wherein the conversion layer converts the first color of the light passing through the diffusion sheet and the prism sheet.”

252. Asada in view of Kinoshita and Cho teaches and suggests this limitation.

253. It was obvious over Asada in view of Kinoshita and Cho to provide a cover on the optical sheet. (See 20E.) It was also obvious for a conversion layer to be provided “on top of the optical sheet.” (See 1D.) Asada also teaches “*wherein the conversion layer converts a first color of light emitted by the light guide plate to a target color, and wherein the conversion layer converts the first color of the light passing through the diffusion sheet and the prism sheet.*” (See 1D, 1F.)

254. Thus, Asada in view of Kinoshita and Cho teaches suggests this limitation and renders obvious claim 20.

Claim 21: “The display device of claim 20, wherein the conversion layer shifts a color coordinate distribution of the light emitted by the light guide plate to a color coordinate having $CIE_x=0.313$ and $CIE_y=0.329$ ”

255. Asada and Kinoshita teach and suggest claim 21. (See claim 12.) The x-y coordinates set forth in this claim refer to “white” in the well-known CIE color

model. (EX1016-Liao at 0014 (noting that the coordinates for white in the CIE color model are $x=0.313$ and $y=0.329$.)

256. White light is the target color for the lighting devices in Asada, Kinoshita, and Cho as well as the combined device discussed in this Ground. (EX1004-Asada at 0032 (referring to “the desired chromaticity of 0.31” which refers to the x coordinate of white light, more specifically 0.313); *see id.* at claims 6-7, 0002-04, 0008, 0011-12, 0020, 0023, 0031-38; EX1005-Kinoshita at 0005, 0024; EX1007-Cho at 4 (explaining that part of the purpose of Cho’s invention is “to convert light generated from LEDs into white light”).)

257. Thus, Asada in view of Kinoshita and Cho discloses and renders obvious this limitation and claim 21.

Claim 22: “The display device of claim 20, wherein the color coordinate conversion layer comprises a coating of color coordinate conversion material provided on a surface of the diffusion sheet”

258. Asada in view of Kinoshita teaches and suggests this limitation. (*See* 23H.)

259. Thus, Asada in view of Kinoshita and Cho renders obvious claim 22.

XII. DECLARATION IN LIEU OF OATH

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under § 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon. If called to testify as to the truth of the matters stated herein, I could and would testify competently.

I declare under penalty of perjury that the foregoing is true and correct.

September 4, 2025

Michael Krames

Michael R. Krames, Ph.D.

Appendix A

MICHAEL KRAMES, PhD, NAE, FIEEE, FIES

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C-LEVEL EXECUTIVE IN PHOTONICS AND SEMICONDUCTORS: TECHNOLOGY, PRODUCT, AND GALLIUM NITRIDE EXPERT

Accomplished R&D Professional with 25+ years of experience in photonics including LEDs and wide bandgap semiconductors. Extensive experience in R&D and manufacturing settings, creating some of the most innovative LEDs for solid-state lighting. Tech team builder, overseeing design, fabrication, characterization, and integration. Work in major companies in the opto semiconductor market, including Hewlett-Packard, Philips and innovative start-ups. PhD in Electrical Engineering. Member of the National Academy of Engineering. IEEE and IES Fellow.

Overview

- Recruit top-performing professionals and make critical hires of technology experts.
- Manage large teams of up to 40, including globally distributed teams across the U.S. and Europe.
- Create unique strategic plans and product roadmaps for innovative technologies.
- Maintain strong partnerships with research institutions to develop industry-leading products.
- Oversee intellectual property (IP) portfolios and file dozens of successful patent applications.

Selected Core Competencies

R&D • Team Leadership • Strategic Planning • Photonics Technologies • Device Design • Speaker
Investment & Fundraising • Recruitment • Project Management • Multimillion USD Budgets • IP Portfolios

PROFESSIONAL EXPERIENCE

ARKESSO LLC – Palo Alto, CA – 2015-present

President

Strategic technology, investment and intellectual property development and consulting for wide bandgap semiconductor technologies and applications, including expert work in patent litigation.

CURRENT CHEMICALS INC – Cleveland, OH – 2025-present

Board of Directors

Guide strategy and growth for a U.S. manufacturer of critical materials and rare-earth compounds serving industrial, high-tech, and defense markets.

IBEAM MATERIALS INC – Sante Fe, NM – 2019-present

Board of Directors

Guide and govern Los Alamos National Lab start-up for depositing semiconductor grade gallium nitride on large area, flexible amorphous materials with application to flexible lighting systems and displays.

SEABOROUGH RESEARCH BV – Amsterdam, NL – 2015-present

Senior Advisor

Drive materials research and development programs for lighting applications using nano materials, focused on advancing the overall solid-state lighting industry in terms of energy savings and performance capability

PROFESSIONAL EXPERIENCE (CONTINUED)

MOMENTUM CAPITAL BV – Amsterdam, NL – 2016-2019, 2025-present

Principal

Technology scouting, assessment, and due diligence for growth market venture financing with a global view and emphasis on clean technology and energy sectors.

SORAA INC – Fremont, CA – 2009-2015

Chief Technology Officer (CTO)

First Management Team member hired to work with Nobel Prize Winner Shuji Nakamura and other key innovators from the University of California, Santa Barbara, to develop leading LED products for professional directional lighting using a brand-new LED materials platform: GaN-on-GaN. Established the GaN-on-GaN LED technology direction and performance roadmaps. Spearheaded projects to commercialize the technology and built successful LED and Product teams from the ground up to implement these. Directly involved in venture and strategic fundraising including successful Series B & C venture capital funding worth more than \$100M.

- Created the world's first LED to surpass halogen and the most efficient light-emitting diodes in the world.
- Built a strong intellectual property portfolio, resulting in more than 140 issued patents for Sora.
- Developed practical strategies for the use of bulk GaN substrate, improving LED performance 10X.
- Supervised bulk GaN ammonothermal growth team and secured strategic investment to cover burn.
- Recruited a core team of talented technology professionals and made critical hires of senior executives.
- Developed LED roadmaps and oversaw innovation from substrate and epitaxy to fabrication and packaging.
- Established the value of higher color quality in products, including color and whiteness rendering.
- Successful implementation of a research contract with Penn State to advance the state of art for LED lighting.

PHILIPS LUMILEDS / LUMILEDS LIGHTING (Originally an HP-Philips Joint Venture) – San Jose, CA – 1999-2009

Executive Vice President, Advanced Laboratories

Formed and managed an R&D laboratory focused on designing groundbreaking LED technologies. Recruited and hired high-performing team, including employees from HP / Agilent Labs. Managed a 40-member department and a budget of up to \$20M. Coordinated with engineering, marketing, product development, and sales teams across the U.S. and Europe. Oversaw technology transfers and managed IP. Developed prototypes for next-generation, solid-state light emitters. Led development of ceramic phosphor technologies.

- Developed the critical LUXEON high power LED platform and managed the technology roadmaps.
- Identified Auger-Meitner recombination as primary loss mechanism in InGaN-based LEDs.
- Designed LED technologies for the iMac, iPhone Flash, digital imaging, and general illumination.
- Created the first automotive LED headlights for the Audi R8, creating new technology breakthroughs.
- Produced a strong intellectual property (IP) portfolio of groundbreaking innovations.
- Oversaw the European phosphor research teams and partners, including nitride-based phosphors
- Spearheaded the creation of thin film flip-chip LED technology and designed new ceramic phosphors.

HEWLETT PACKARD CO, Optoelectronics Division – San Jose, CA – 1995-1999

Design Engineer and Engineering Scientist

Developed innovative, high-energy LED technologies for traffic signal, road lighting, and automotive applications. Developed high-power LED products using novel device structures and epitaxial layer design.

- Worked with teams to develop the world's first high-power LEDs, expanding from milli-Watts to Watt-class.
- Successfully developed the first LED to surpass 100 lumens per Watt.
- Re-engineered LED chip design for red and amber emitters, delivering groundbreaking performance.
- Delivered record-setting performance for visible-spectrum LEDs with 55%+ external quantum efficiency.

EXPERT TESTIFYING EXPERIENCE (LAST 5 YEARS)

Case Description	Role	Jurisdiction	Testimony
SEOUL SEMICONDUCTOR CO., LTD. and SEOUL VIOSYS CO., LTD. (Plaintiffs) vs. TECHNICAL CONSUMER PRODUCTS, INC. (Defendant)	Expert witness for TCP	UNITED STATES DISTRICT COURT FOR THE DISTRICT OF DELAWARE	Deposition testimony Aug 21, 2025
Luminex International Company Ltd. (Petitioner) vs. Signify Holding BV (Patent Owner)	Expert witness for Signify	U.S. PATENT AND TRADEMARK OFFICE BEFORE THE PATENT TRIAL AND APPEAL BOARD	Deposition testimony Mar 13, 2025
Feit Electric Company, Inc. (Plaintiff) vs. LEDVANCE, LLC (Defendant)	Expert witness for LEDVANCE	UNITED STATES DISTRICT COURT EASTERN DISTRICT OF KENTUCKY	Deposition testimony Jan 10, 2025
Signify NA Corp. & Signify Holding BV (Plaintiffs) vs. LEPRO Innovation Inc. et al. (Defendants)	Expert witness for Signify	UNITED STATES DISTRICT COURT DISTRICT OF NEVADA	Deposition testimony Oct 2, 2024
ALSI Holdings, LLC (Plaintiff) vs. Current Lighting Solutions, LLC, and HLI Solutions, Inc. (Defendants)	Expert witness for Current	UNITED STATES DISTRICT COURT WESTERN DISTRICT OF TEXAS WACO DIVISION	Deposition testimony Aug 14, 2023
CAO Lighting, Inc., (Plaintiff) vs. GE Lighting, Inc., General Electric Co., and Consumer Lighting (U.S.), LLC d/b/a GE Lighting (Defendants)	Expert witness for GE	UNITED STATES DISTRICT COURT DISTRICT OF DELAWARE	Trial testimony June 8, 2023
Wolfspeed, Inc. & Ideal Industries Lighting, LLC d/b/a Cree Lighting (Petitioners) v. CAO Lighting, Inc. (Patent Owner)	Expert witness for Wolfspeed	U.S. PATENT AND TRADEMARK OFFICE BEFORE THE PATENT TRIAL AND APPEAL BOARD	Deposition testimony May 15, 2023
CAO Lighting, Inc., (Plaintiff) vs. GE Lighting, Inc., General Electric Co., and Consumer Lighting (U.S.), LLC d/b/a GE Lighting (Defendants)	Expert witness for GE	UNITED STATES DISTRICT COURT DISTRICT OF DELAWARE	Jury trial testimony Feb 16, 2023
CAO Lighting, Inc., (Plaintiff) vs. GE Lighting, Inc., General Electric Co., and Consumer Lighting (U.S.), LLC d/b/a GE Lighting (Defendants)	Expert witness for GE	UNITED STATES DISTRICT COURT DISTRICT OF DELAWARE	Deposition testimony May 25, 2022
Seoul Semiconductor Co., Ltd., and Seoul Viosys Co., Ltd. (Plaintiffs/Counter-Defendants) v. Satco Products, Inc. (Defendant/Counter-Plaintiff)	Expert witness for Satco	UNITED STATES DISTRICT COURT EASTERN DISTRICT OF NEW YORK	Deposition testimony December 2, 2021
Satco Products, Inc. (Petitioner) v. Seoul Semiconductor Co., Ltd. (Patent Owner), IPR2021-00230	Expert witness for Satco	U.S. PATENT AND TRADEMARK OFFICE BEFORE THE PATENT TRIAL AND APPEAL BOARD	Deposition testimony August 20, 2021

Satco Products, Inc. (Petitioner) v. Seoul Viosys Co., Ltd. (Patent Owner), IPR2020-00750	Expert witness for Satco	U.S. PATENT AND TRADEMARK OFFICE BEFORE THE PATENT TRIAL AND APPEAL BOARD	Deposition testimony April 23, 2021
Satco Products, Inc. (Petitioner) v. Seoul Semiconductor Co., Ltd. (Patent Owner), IPR2020-00410	Expert witness for Satco	U.S. PATENT AND TRADEMARK OFFICE BEFORE THE PATENT TRIAL AND APPEAL BOARD	Deposition testimony March 4, 2021

EDUCATION

UNIVERSITY OF ILLINOIS: URBANA-CHAMPAIGN – Urbana, IL

PhD in Electrical Engineering • Master of Science in Electrical Engineering

Research Assistant • Solid State Devices Laboratory • Electro-Optic Systems

Laboratory Teaching Assistant • Department of Electrical and Computer Engineering

PhD.: Native Oxidation of Area-Selective-Disordered AlGaAs-GaAs: Deep Oxide Structures for Device Applications

Master: Volume Holographic and Surface-Relief Transmission Gratings in Wavelength-Division-Multiplexing Receivers

UNIVERSITY OF TEXAS – Austin, TX

Bachelor of Science in Electrical Engineering, with High Honors

Outstanding Student Summer Program (Sandia Nationals Labs, 1988)

MIT Executive Education Courses, 2006

MEMBERSHIPS AND LEADERSHIP

- National Academy of Engineering (2025-)
- IEEE Fellow • IEEE Consultants Network of Silicon Valley
- Chair, IEEE Nick Holonyak, Jr. Medal (2023-2024)
- IES Fellow • University of Texas at Austin ECE Academy of Distinguished Alumni
- U.S. Department of Energy Solid-State Lighting Roundtable
- Panelist, Basic Energy Sciences Workshop on Solid-State Lighting
- Chair, SPIE Photonics West conferences on LEDs (2016-)
- Organizing Committee, Phosphor & Quantum Dots Industry Forum (2016-)
- Executive Committee, CS Mantech (2021-)

PUBLICATIONS

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31. **High-performance blue and green laser diodes based on nonpolar/semipolar bulk GaN substrates**; Raring, J.W., Schmidt, M.C., Poblentz, C., Li, B., Chang, Y.-C., Mondry, M.J., Lin, Y.-D., Krames, M.R., Craig, R., Speck, J.S., Denbaars, S.P., Nakamura, S.; (2011) Proceedings of SPIE - The International Society for Optical Engineering, 7939, art. no. 79390Y.
32. **High-efficiency blue and true-green-emitting laser diodes based on non-c-plane oriented GaN substrates**; Raring, J.W., Schmidt, M.C., Poblentz, C., Chang, Y.-C., Mondry, M.J., Li, B., Iveland, J., Walters, B., Krames, M.R., Craig, R., Rudy, P., Speck, J.S., DenBaars, S.P., Nakamura, S.; (2010) Applied Physics Express, 3 (11), art. no. 112101.
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35. **History, development, and applications of high-brightness visible light-emitting diodes**; Dupuis, R.D., Krames, M.R.; (2008) Journal of Lightwave Technology, 26 (9), pp. 1154-1171.
36. **Carrier distribution in (0001) InGaNGaN multiple quantum well light-emitting diodes**; David, A., Grundmann, M.J., Kaeding, J.F., Gardner, N.F., Mihopoulos, T.G., Krames, M.R.; (2008) Applied Physics Letters, 92 (5), art. no. 053502.
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38. **Research challenges to ultra-efficient inorganic solid-state lighting**; Phillips, J.M., Coltrin, M.E., Crawford, M.H., Fischer, A.J., Krames, M.R., Mueller-Mach, R., Mueller, G.O., Ohno, Y., Rohwer, L.E.S., Simmons, J.A., Tsao, J.Y.; (2007) Laser and Photonics Reviews, 1 (4), pp. 307-333.
39. **Performance and trends of high power Light Emitting Diodes**; Bierhuizen, S., Krames, M., Harbers, G., Weijers, G.; (2007) Proceedings of SPIE - The International Society for Optical Engineering, 6669, art. no. 66690B, .
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47. **Performance of High Power LEDs in display illumination applications**; Bierhuizen, S., Harbers, G., Krames, M.; (2006) IDW '06 - Proceedings of the 13th International Display Workshops, 3, pp. 1715-1718.
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50. **High power InGaN LEDs & applications**; Krames, M.R.; (2005) International Semiconductor Device Research Symposium, art. no. 1595990, p. 86.
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PRESENTATIONS (RECENT)

1. **The unspoken challenge for linear fluorescent retrofits - and a solution**, Roy S.; Krames M. R.; 17th Int'l Symposium on Science & Technology of Lighting (LS:17); Toulouse, FR (2022)
2. **UV-C LEDs for Germicidal/Virucidal Applications**, Krames M. R.; U.S. Dept. of Energy Solid-State Lighting R&D Workshop – GUV Panel; Virtual (2022)
3. **UV-C Technology Roadmap**, Krames M. R.; Strategies In Light; Virtual (2021)
4. **UV-C Advancements Enable Innovative Germicidal Uses Displacing Lamps In Some Scenarios**; Krames M. R.; LedsMagazine Webinar; Virtual (2021)
5. **Ultra-Violet Germicidal Irradiation (UVGI): LEDs vs. Hg Lamps**; Krames M. R.; U.S. Dept. of Energy GUV R&D Discussion; Virtual (2020)
6. **Converters for Illumination: New Approaches and Applications**; Krames, M.; Phosphors & Quantum Dots Industry Forum; Virtual (2020)
7. **Gallium Nitride and the Transformation of the Lighting Industry**; Krames, M.; Stanford Optical Society Seminar; Stanford University, Stanford, CA (2020)
8. **How LEDs are Changing the World**; Krames, M.; UT ECE Colloquia Seminar; University of Texas, Austin, TX (2018)
9. **Status and Prospects for GaN-based LEDs / Lasers and Their Applications**; Krames, M.; Optics & Photonics International Congress: LEDIA'17; Yokohama, JP (2017)
10. **Legacy: The Birth of Solid-State Lighting in Silicon Valley**; Krames, M.; Invited Seminar at Lumileds; San Jose, CA (2017)
11. **The Solid-State Lighting Revolution: Technologies that will Shape the Future of Lighting**; Krames, M.; SPIE Photonics West – Panel Presentation; San Francisco, CA (2017)

12. ***The Challenge for Bulk Nitride Materials***; Krames, M.; Workshop on Ultra-Precision Processing for Wide Bandgap Semiconductors (WUPP); Monterey, CA (2017)
13. ***Status and Future Prospects for Visible-Spectrum LEDs***; Krames, M.; Society for Information Display – Display Week; San Jose, CA (2016)
14. ***LEDs for Lighting Applications: Past, Present, and Future***; Krames, M.; IEEE Photonics Society – Santa Clara Valley Chapter; Santa Clara, CA (2016)
15. ***What is Next for LEDs?***; Krames, M.; Strategies in Light; Santa Clara, CA (2016)
16. ***Opportunities for Down-Converters – Lighting Device Perspective***; Krames, M.; Phosphor Global Summit & Quantum Dot Forum; Newport Beach, CA (2016)
17. ***Challenges for Power Electronics in Solid-State Lighting***; Krames, M.; ARPA-e CIRCUITS Workshop; Washington, DC (2016)
18. ***Triumph of GaN Lighting***; Krames, M.; UC Berkeley ECE Seminar; Berkeley, CA (2015)

PATENTS (U.S. only)

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|-----|------------|---|
| 1) | 12,369,438 | System and method for providing color light sources ... |
| 2) | 12,286,576 | Luminescent composition |
| 3) | 12,107,113 | Var. composition ternary compound semi. alloys, structures, and devices |
| 4) | 11,879,085 | Converter system |
| 5) | RE49,677 | Reusable nitride wafer, method of making, and use thereof |
| 6) | 11,725,783 | Circadian-friendly LED light source |
| 7) | 11,662,067 | LED lamps with improved quality of light |
| 8) | 11,611,023 | System and method for selected pump LEDs with multiple phosphors |
| 9) | 11,605,618 | LED array for in-plane optical interconnects |
| 10) | 11,511,071 | Circadian-friendly LED light sources |
| 11) | 11,287,090 | Circadian-friendly LED light source |
| 12) | 11,233,181 | Converter system |
| 13) | 11,162,026 | Converter system |
| 14) | 11,105,473 | LED lamps with improved quality of light |
| 15) | 10,955,608 | Circadian-friendly LED light sources |
| 16) | 10,900,615 | Circadian-friendly LED light source |
| 17) | 10,847,625 | Indium-gallium-nitride structures and devices |
| 18) | 10,830,405 | Sunlight-based large area light source and large area luminaire |
| 19) | 10,700,244 | System and method for selected pump LEDs with multiple phosphors |
| 20) | 10,693,041 | High-performance LED fabrication |
| 21) | 10,677,981 | Large area light source and large area luminaire |
| 22) | 10,557,595 | LED lamps with improved quality of light |
| 23) | 10,553,754 | Power light emitting diode and method with uniform current density |
| 24) | 10,529,902 | Small LED source with high brightness and high efficiency |
| 25) | 10,436,422 | Multi-function active accessories for LED lamps |
| 26) | 10,324,250 | Circadian-friendly LED light sources |
| 27) | 10,312,422 | Light emitting devices with optical elements and bonding layers |
| 28) | 10,312,404 | Semi. light emitting device growing active layer on textured surface |
| 29) | 10,290,775 | Luminescent ceramic for a light emitting device |
| 30) | 10,168,009 | LED lamps with improved quality of light |

- 31) 10,147,850 System and method for providing color light sources in proximity to predetermined wavelength conversion structures
- 32) 10,139,056 LED lamps with improved quality of light
- 33) 10,137,277 Circadian-friendly LED light source
- 34) 10,115,865 High-performance LED fabrication
- 35) 10,087,550 Reusable nitride wafer, method of making, and use thereof
- 36) 10,084,121 Small LED source with high brightness and high efficiency
- 37) 10,076,633 Circadian-friendly LED light source
- 38) 9,995,439 Glare reduced compact lens for high intensity light source
- 39) 9,722,148 Luminescent ceramic for a light emitting device
- 40) 9,677,723 LED lamps with improved quality of light
- 41) 9,660,152 System and method for selected pump LEDs with multiple phosphors
- 42) 9,653,554 Reusable nitride wafer, method of making, and use thereof
- 43) 9,650,723 Large area seed crystal for ammonothermal crystal growth and method
- 44) 9,640,724 III-nitride LED with double heterostructure light emitting region
- 45) 9,618,183 Apportioning optical projection paths in an LED lamp
- 46) 9,589,792 High quality group-III metal nitride crystals, methods of making, and methods of use
- 47) 9,583,683 Light emitting devices with optical elements and bonding layers
- 48) 9,583,678 High-performance LED fabrication
- 49) 9,564,553 Power LED and method with uniform current density operation
- 50) 9,435,525 Multi-part heat exchanger for LED lamps
- 51) 9,419,189 Small LED source with high brightness and high efficiency
- 52) 9,410,664 Circadian friendly LED light source
- 53) 9,368,695 LED lamps with improved quality of light
- 54) 9,360,190 Compact lens for high intensity light source
- 55) 9,359,260 Luminescent ceramic for a light emitting device
- 56) 9,293,667 System and method for selected pump LEDs with multiple phosphors
- 57) 9,293,644 Power LED and method with uniform current density operation
- 58) 9,267,661 Apportioning optical projection paths in an LED lamp
- 59) 9,117,944 Semiconductor light emitting devices grown on composite substrates
- 60) D736,724 LED lamp with accessory
- 61) D736,723 LED lamp
- 62) 9,046,227 LED lamps with improved quality of light
- 63) D730,302 Heat sink
- 64) 9,000,450 Grown photonic crystals in semiconductor light emitting devices
- 65) 8,985,794 Providing remote blue phosphors in an LED lamp
- 66) 8,933,644 LED lamps with improved quality of light
- 67) 8,911,518 Method and system for dicing substrates containing gallium and nitrogen material with conductive core via structures
- 68) 8,905,588 System and method for providing color light sources in proximity to predetermined wavelength conversion structures
- 69) 8,884,517 Illumination sources with thermally-isolated electronics
- 70) 8,847,252 III-nitride LED with double heterostructure light emitting region
- 71) 8,846,423 Bonding an optical element to a light emitting device

- 72) 8,748,923 Wavelength-converted semiconductor light emitting device
- 73) 8,748,912 Common optical element for an array of phosphor converted LEDs
- 74) 8,740,413 System and method for providing color light sources in proximity to
predetermined wavelength conversion structures
- 75) 8,729,559 Method of making bulk InGaN substrates and devices thereon
- 76) 8,686,458 Power light emitting diode and method with current density operation
- 77) 8,679,869 Contact for a semiconductor light emitting device
- 78) 8,628,985 Light emitting devices with improved light extraction efficiency
- 79) 8,597,967 Method and system for dicing substrates containing gallium and
nitrogen material
- 80) 8,502,465 Power light emitting diode and method with current density operation
- 81) 8,492,244 Methods for relaxation and transfer of strained layers and structures
fabricated thereby
- 82) 8,486,771 Methods of forming relaxed layers of semi. materials, semi. structures,
devices and engineered substrates including same
- 83) 8,482,104 Method for growth of indium-containing nitride films
- 84) 8,481,408 Relaxation of strained layers
- 85) 8,471,280 Silicone based reflective underfill and thermal coupler
- 86) 8,455,913 Package-integrated thin film LED
- 87) 8,450,754 Series connected flip chip LEDs with growth substrate removed
- 88) 8,445,929 Wavelength-converted semiconductor light emitting device
- 89) 8,415,694 Light emitting devices with improved light extraction efficiency
- 90) 8,334,543 III-V light emitting device including a light extracting structure
- 91) 8,334,155 Substrate for growing a III-V light emitting device
- 92) 8,288,186 Substrate for growing a III-V light emitting device
- 93) 8,278,674 Luminescent ceramic element for a light emitting device
- 94) 8,203,153 III-V light emitting device including a light extracting structure
- 95) 8,174,025 Semiconductor light emitting device including porous layer
- 96) 8,163,575 Grown photonic crystals in semiconductor light emitting devices
- 97) 8,153,475 Back-end processes for substrates re-use
- 98) 8,114,692 Light source including a wavelength-converted semi. LED and a filter
- 99) 8,105,852 Method of forming a composite substrate and growing a III-V light
emitting device over the composite substrate
- 100) 8,080,828 Low profile side emitting LED with window layer and phosphor layer
- 101) 8,067,254 Common optical element for an array of phosphor converted LED
- 102) 8,062,916 Series connected flip chip LEDs with growth substrate removed
- 103) 8,053,905 Compliant bonding structures for semiconductor devices
- 104) 8,049,234 Light emitting devices with improved light extraction efficiency
- 105) 8,039,866 Mount for a semiconductor light emitting device
- 106) 7,981,767 Methods for relaxation and transfer of strained layers and structures
fabricated thereby
- 107) 7,902,564 Multi-grain luminescent ceramics for light emitting devices
- 108) 7,888,691 Light source including a wavelength-converted semi. LED and a filter
- 109) 7,880,186 III-nitride light emitting device with DH light emitting region
- 110) 7,875,984 Compliant bonding structures for semiconductor devices

111)	7,875,533	Package-integrated thin film LED
112)	7,863,631	A1InGaP LED having reduced temperature dependence
113)	7,808,011	Semi. light emitting devices including in-plane light emitting layers
114)	7,804,100	Polarization-reversed III-nitride light emitting device
115)	7,791,096	Mount for a semiconductor light emitting device
116)	7,675,084	Photonic crystal light emitting device
117)	7,663,148	III-nitride light emitting device with reduced strain light emitting layer
118)	7,642,108	LED including photonic crystal structure
119)	7,626,210	Low profile side emitting LED
120)	7,601,989	LED with porous diffusing reflector
121)	7,544,525	AllnGaP LED having reduced temperature dependence
122)	7,514,721	Luminescent ceramic element for a light emitting device
123)	7,491,565	III-nitride light emitting devices fabricated by substrate removal
124)	7,488,621	Package-integrated thin film LED
125)	7,442,965	Photonic crystal light emitting device
126)	7,419,839	Bonding an optical element to a light emitting device
127)	7,408,201	Polarized semiconductor light emitting device
128)	7,402,840	Selective filtering of wavelength-converted semi. light emitting devices
129)	7,361,938	Luminescent ceramic for a light emitting device
130)	7,341,878	Wavelength-converted semiconductor light emitting device
131)	7,294,862	Photonic crystal light emitting device
132)	7,279,718	LED including photonic crystal structure
133)	7,279,345	Method of forming LEDs with improved light extraction efficiency
134)	7,268,371	Light extraction from a semiconductor LED via chip shaping
135)	7,256,483	Package-integrated thin film LED
136)	7,244,630	A1InGaP LED having reduced temperature dependence
137)	7,221,000	Reverse polarization light emitting region for a semiconductor LED
138)	7,122,839	Semiconductor LEDs with graded composition light emitting layers
139)	7,087,941	III-phosphide light emitting devices with thin active layers
140)	7,064,355	Light emitting diodes with improved light extraction efficiency
141)	7,053,419	Light emitting diodes with improved light extraction efficiency
142)	7,026,663	Selective filtering of wavelength-converted semiconductor LEDs
143)	7,015,054	Semiconductor light emitting device and method
144)	7,012,279	Photonic crystal light emitting device
145)	6,995,389	Heterostructures for III-nitride light emitting devices
146)	6,992,334	Multi-layer highly reflective ohmic contacts for semiconductor devices
147)	6,989,555	Strain-controlled III-nitride light emitting device
148)	6,956,246	Resonant cavity III-nitride LEDs fabricated by growth substrate removal
149)	6,946,309	III-Phosphide and III-Arsenide flip chip light-emitting devices
150)	6,903,376	Selective placement of QWs in flipchip LEDs for improved light extract.
151)	6,849,472	Nitride semiconductor device with reduced polarization fields
152)	6,847,057	Semiconductor light emitting devices
153)	6,844,571	III-nitride light-emitting device with increased light generating capability
154)	6,800,500	III-nitride light emitting devices fabricated by substrate removal
155)	6,784,463	III-Phospide and III-Arsenide flip chip light-emitting devices

156)	6,744,077	Selective filtering of wavelength-converted semi. light emitting devices
157)	6,683,327	Nucleation layer for improved light extract. from light emitting devices
158)	6,649,440	Aluminum indium gallium nitride-based LED having thick epitaxial layer for improved light extraction
159)	6,646,292	Semiconductor light emitting device and method
160)	6,642,652	Phosphor-converted light emitting device
161)	6,576,488	Using electrophoresis to produce a conformally coated phosphor-converted light emitting semi.
162)	6,570,190	LED having angled sides for increased side light extraction
163)	6,525,335	Light emitting semi. devices including wafer bonded heterostructures
164)	6,521,914	III-Nitride LED with increased light generating capability
165)	6,514,782	Method of making a III-N LED with increased light generating capability
166)	6,504,171	Chirped multi-well active region LED
167)	6,486,499	III-nitride light-emitting device with increased light generating capability
168)	6,420,199	Methods for fabricating light emitting devices having aluminum gallium indium nitride structures and mirror stacks
169)	6,323,063	Forming LED having angled sides for increased side light extraction
170)	6,320,206	LEDs having wafer bonded AlGaInN structures and mirror stacks
171)	6,280,523	Thickness tailoring of wfr. bonded AlxGayInzN struct.'s by laser melting
172)	6,229,160	Light extraction from a semi. light-emitting device via chip shaping
173)	6,133,589	AlGaInN-based LED having thick epi layer for improved light extraction
174)	6,046,465	Buried reflectors for light emitters in epi. mat'l & method for producing
175)	5,779,924	Ordered interface texturing for a light emitting device
176)	5,400,354	Laminated upper cladding structure for a light-emitting device