

UNITED STATES PATENT AND TRADEMARK OFFICE

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BEFORE THE PATENT TRIAL AND APPEAL BOARD

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ORSTAR INDUSTRIAL CO., LTD.,  
Petitioner,

v.

COSMO LIGHTING INC.,  
Patent Owner.

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Case IPR2015-01787  
Patent 7,926,978 B2

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Before JAMESON LEE, JAMES T. MOORE, and JENNIFER S. BISK,  
*Administrative Patent Judges.*

BISK, *Administrative Patent Judge.*

FINAL WRITTEN DECISION

*35 U.S.C. § 318(a) and 37 C.F.R. § 42.73*

## I. INTRODUCTION

### A. *Background*

Orstar Industrial Co. Ltd. filed a Petition to institute *inter partes* review of claims 1–3 (the “challenged claims”) of U.S. Patent No. 7,926,978 B2 (“the ’978 patent”). Paper 1 (“Pet.”). On January 25, 2016, we granted the Petition, instituting trial on whether the challenged claims are unpatentable as obvious over Popovich,<sup>1</sup> Lin-US,<sup>2</sup> and Lin-CN.<sup>3</sup> Paper 15 (“Institution Decision” or “Inst. Dec.”).

During the trial, Patent Owner filed a Response (Paper 19, “PO Resp.”) and Petitioner filed a Reply (Paper 23, “Reply”). We held an oral hearing on October 3, 2016. Paper 29 (“Tr.”).

This is a Final Written Decision pursuant to 35 U.S.C. § 318(a) and 37 C.F.R. § 42.73. For the reasons set forth the below, we conclude that Petitioner has shown by a preponderance of evidence that the challenged claims are *unpatentable*.

### B. *Related Proceedings*

Patent Owner indicates that the ’978 patent is at issue in *Cosmo Lighting Inc. v. Target Corporation*, 2:15-cv-09243-JAK-AJW (C.D. Cal.). Paper 12. Another Petition challenging the ’978 patent was terminated on September 28, 2016. IPR2016-00296, Paper 18.

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<sup>1</sup> US Patent No. 7,301,174 B1 (Ex. 1012) (“Popovich”).

<sup>2</sup> US 2003/0137839 A1 (Ex. 1016) (“Lin-US”).

<sup>3</sup> CN 1514498 A (Ex. 1018) (“Lin-CN”). Ex. 1019 is an English translation of Lin-CN and Ex. 1020 is a certification of this translation. For purposes of this Decision, we will refer only to Ex. 1019 when discussing Lin-CN.

*C. The '978 Patent*

The '978 patent describes a light set with surface mounted light emitting components. Ex. 1001, 1:6–8. According to the '978 patent, at the time of the invention, traditional lighting devices were being replaced with semiconductor light emitting components, including the light emitting diode (“LED”), because of LED’s many advantages, including easy mass production. *Id.* at 1:12–20. The '978 patent states that one drawback to LEDs, however, is that they have insufficient brightness on their own, causing light sets to combine or serially connect multiple LEDs to obtain the desired brightness. *Id.* at 1:32–36.

The '978 patent describes a “conventional LED” as including “an LED dice encapsulated in a lamp-shape package,” with a pair of leads extending from the LED dice through the package to an external power source. *Id.* at 1:21–24. Each of the pair of leads “are separately soldered to a positive conductor and a negative conductor.” *Id.* at 1:24–27. According to the '978 patent, “it is uneasy to control the soldering quality” of these separately soldered leads, resulting in both low reliability and a low production rate. *Id.* at 1:37–45.

The '978 patent purports to solve these problems with a light set that includes two adjacent conducting wires, each of which is enclosed by an insulating layer. *Id.* at 1:56–2:15. Corresponding contact-pad areas are formed at predetermined intervals on each wire by exposing the conductor from the insulating layer. *Id.* The light emitting component is then straddled between two contact pad areas, one lead connected to each conducting wire, thus electrically connecting the two adjacent conducting wires. *Id.* at 2:16–23. In this configuration, “it is not necessary to solder

leads of the surface mounted light emitting components to the two conducting wires.” *Id.* at 2:25–27. “Instead, every surface mounted light emitting component can be directly straddled” on the contact pads of the two wires “via a conductive material,” thus, avoiding the production issues discussed above. *Id.* at 2:27–33. In addition, the ’978 patent states that the configuration allows for relatively large contact areas leading to high reliability of the end product. *Id.* at 2:38–44.

Figure 1, reproduced below, is a perspective view of a light set according to a preferred embodiment of the ’978 patent.

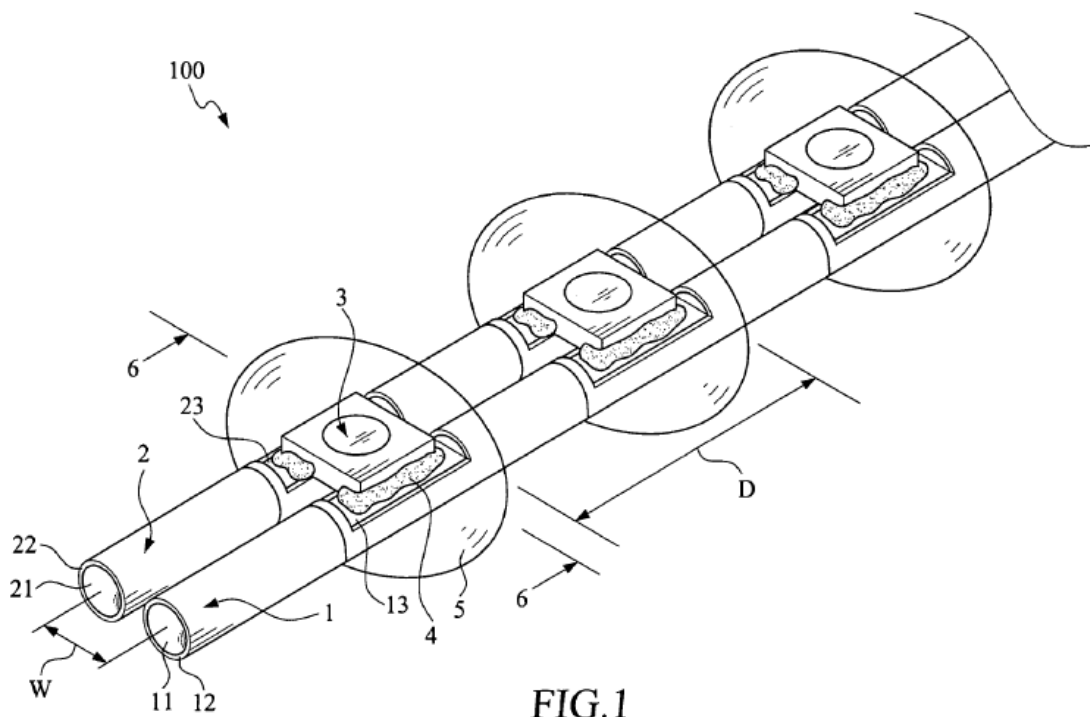


FIG.1

Figure 1 of the ’978 patent shows light set 100, including first conducting wire 1, second conducting wire 2 “parallelly disposed adjacent to” first conducting wire 1, and surface mounted light emitting components 3. *Id.* at 3:8–14, 22–24. The conducting wires include conductors 11, 21, and insulating layers 12, 22. *Id.* at 3:15–31.

Figure 2, reproduced below, shows, in more detail, the two conducting wires of light set 100. *Id.* at 2:56–57.

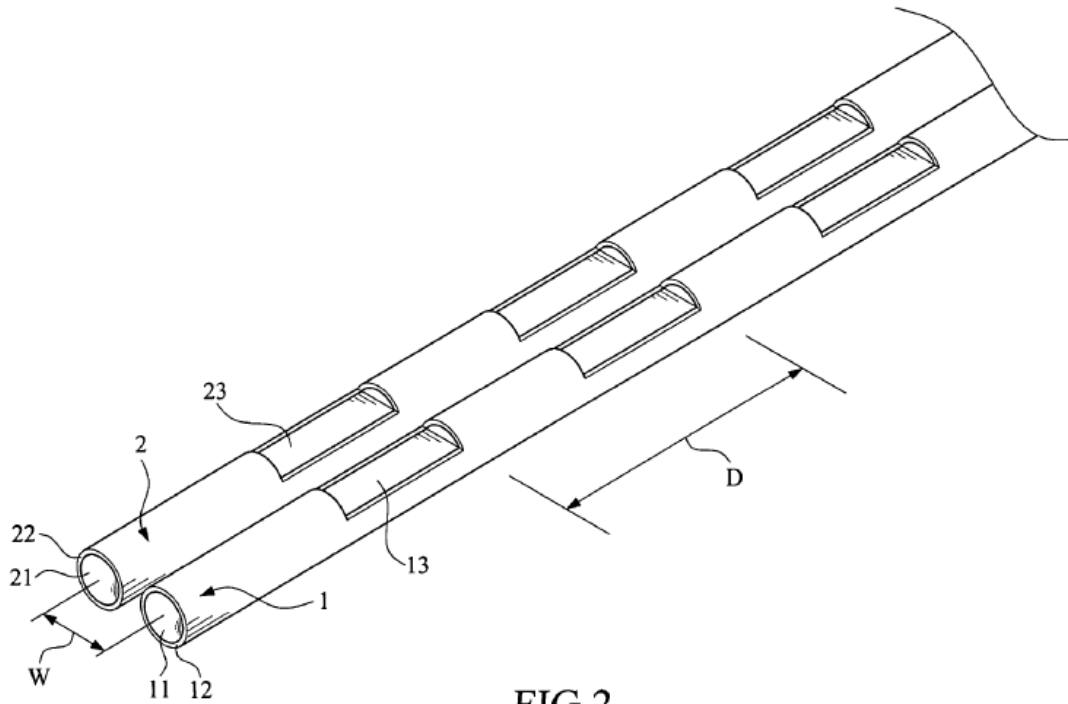


Figure 2 of the '978 patent shows first and second conducting wires 1, 2, each with a plurality of adjacent contact-pad areas 13, 23 formed at predetermined intervals D. *Id.* at 3:38–42. Each wire's conductor 11, 21 is exposed at each of the contact-pad areas. *Id.* at 3:42–47.

Figure 6, reproduced below, shows an enlarged cross sectional view taken along line 6-6 of Figure 1. *Id.* at 2:66–67.

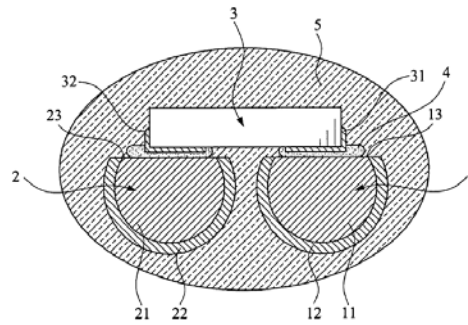


Figure 6, above, shows surface mounted light emitting components 3 straddling the first and second conducting wires 1, 2 at the contact-pad areas 13, 23. *Id.* at 4:63–5:3. “[A] layer of transparent package 5 is further applied to an outer side of every paired first and second contact-pad areas 13, 23 on the first and the second conducting wire 1, 2 and the surface mounted light emitting component 3 bonded thereto.” *Id.* at 5:1–12. This packaging: (1) prevents light 3 and conductors 11, 12 from electrically contacting with an external environment; (2) protects light 3 against dust and particles; and (3) strengthens the connection between light 3 and conducting wires 1,2 leading to improved reliability. *Id.* at 5:1–22.

*D. Illustrative Claim*

Claim 1, reproduced below, is the only independent claim of the '978 patent. It is illustrative of the claimed subject matter:

1. A light set, comprising:
  - a first conducting wire having a first conductor and a first insulating layer enclosing the first conductor, said first insulating layer having a plurality of displaced first openings through said first insulating layer, said first openings defining a respective plurality of first contact-pad areas exposing said first conductor within said plurality of said first contact pad areas;
  - a second conducting wire being disposed adjacent to the first conducting wire, and having a second conductor and a

second insulating layer enclosing the second conductor, said second insulating layer having a plurality of displaced second openings through said second insulating layer aligned with said first openings, said second openings defining a respective plurality of second contact-pad areas exposing said second conductor within said plurality of said second contact pad area;

at least one surface mounted light emitting component being straddled on and between respective first and second contact-pad areas on the first and the second conducting wire; the surface mounted light emitting component having a first lead and a second lead, which are electrically connected to the first conductor of the first conducting wire and the second conductor of the second conducting wire, respectively, via a conductive paste sandwiched between respective first and second leads and said first and second conducting wires; and

a plurality of transparent packages encapsulating every pair of first and second contact-pad areas on the first and second conducting wires and the surface mounted light emitting component bonded thereto;

wherein the first and the second conducting wire [sic] are enamel-insulated wires; and the at least one surface mounted light emitting component is a surface mounted light emitting diode.

## II. ANALYSIS

### A. *Level of Ordinary Skill in the Art*

In determining the level of ordinary skill in the art, various factors may be considered, including the “type of problems encountered in the art; prior art solutions to those problems; rapidity with which innovations are made; sophistication of the technology; and educational level of active workers in the field.” *In re GPAC, Inc.*, 57 F.3d 1573, 1579 (Fed. Cir. 1995) (citation omitted). Petitioner asserts that a person of ordinary skill in the art in the field of the '978 patent would have had “at least an associate degree in

mechanical or electrical engineering and having at least two years of experience with electronic packaging or printed wiring board assembly” or “at least four years of experience with electronic packaging or printed wiring board assembly.” Pet. 28 (citing Ex. 1002 ¶ 49).

Patent Owner does not specifically address Petitioner’s statements regarding the level of ordinary skill in the art, but asserts that a person of ordinary skill “would have at least a Masters in Materials Sciences, Electrical Engineering or in Mechanical Engineering with at least 3 years[] experience in packaging of optoelectronic devices.” PO Resp. 15.

The parties’ dispute is relevant to Patent Owner’s contention that Petitioner’s declarant, Dr. Viswanadham Puligandla (“Dr. Puligandla”)<sup>4</sup>, is not a person of ordinary skill in the art because he “does *not* have experience in the packaging of light-emitting diodes, in optoelectric packaging, in optic packaging or in light strings.” PO Resp. 16.

The ’978 patent is directed to improving control and manufacture of the connection of the light emitting components to the conductors. Ex. 1001, 1:37–64. It describes the relevant problems encountered in the art as those caused by soldering leads from LEDs to conductors. *Id.*; *see also* PO Resp. 3–4 (“The ’978 patent recognizes the problems caused by soldering leads from an LED die to conductors, such as poor lead soldering quality, damage based on external force, and low reliability, as well as the need to solder each of the elements in a light string one by one.”), *id.* at 7–8 (“the ’978 patent accomplishes its primary purpose without soldering the leads of the surface mounted light-emitting components” to the conductors, and as a

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<sup>4</sup> Dr. Puligandla’s declaration is Exhibit 1002.



result “assembly and production of the light set becomes easier”); Ex. 2001 ¶ 21 (“The ’978 Patent was game changing in making LED string light sets cheaply and reliably”). The ’978 patent is not explicitly directed to issues associated with how light is transmitted, diffracted, and reflected, but instead is directed generally to how LEDs, as electronic devices, are packaged. In fact, the ’978 states only that “the angle of divergence of the light emitted from the surface mounted light emitting components 3 can be adjusted via the transparent package 5 to meet a user’s requirement.” Ex. 1001, 5:22–25. The rest of the ’978 patent is directed to general packaging of LEDs in the manufacturing of a light set. Other than the need for multiple LEDs to ensure sufficient brightness of the light set (Ex. 1001, 32–36), the Specification identifies no specific problem that stems from the device being an optoelectronic device as opposed to other semiconductor electronic devices. From this evidence, we conclude that a person of ordinary skill in the art with respect to the ’978 patent would be skilled in the field of packaging of semiconductor electronic devices, e.g., manufacturing of light sets.

Patent Owner asserts that experience in the field of semiconductor packaging “does not translate into knowledge of the state of the art or technical requirements regarding optoelectronic packaging or light strings,” which use “very different materials” that “exhibit different properties and characteristics.” *Id.* at 16–17; Ex. 2001 ¶ 38. The argument is not persuasive, because, on this record, optoelectronic devices are semiconductor devices. *See, e.g.*, Ex. 1001, 1: 12–13 (“In recent years, semiconductor light emitting components have gradually replaced the traditional lighting devices”); 1:60–64 (“Another object of the present

invention is to provide a light set with surface mounted light emitting components, which has stable and firm structure to protect the semiconductor light emitting components”); Ex. 1012, 1:14–19 (“Conventional LEDs generally incorporate a substrate, a light emitting part including a light emitting layer formed on a laminated nitride semiconductor.”); Ex. 1002 ¶ 40; Ex. 2001 ¶ 63 (“LED die refers just to the semiconductor chip”).

Thus, one with ordinary skill in the art in the field of semiconductor device packaging would have a basic working knowledge of optoelectronic device packaging. The ’978 patent itself does not indicate that there is any complexity with respect to choosing the encapsulating material. In fact, the only discussion of that material in the ’978 patent is “[i]n this case, it is of course a transparent material [that] should be selected for the transparent package 5, so that light emitted from the surface mounted light emitting components 3 can pass through the transparent package 5.” Ex. 1001, 5:25–29.

Patent Owner asserts that a person of ordinary skill “in the area of optoelectronics must consider issues associated with how light is transmitted, diffracted, reflected, and the like.” The argument is also unpersuasive for two reasons. First, the ’978 patent is about the packaging of an LED, not about designing an LED with improved optical characteristics. Second, Patent Owner has not shown that Dr. Pugliandla did not consider how light is transmitted, diffracted, reflected, and the like.

Moreover, both parties agree that when designing a light set to solve the relevant problems, a person of ordinary skill in the art would choose materials based on researching the manufacturer’s specifications of various

materials—not on any particular knowledge of optoelectronics. Tr. 35:4–9 (Patent Owner’s counsel stating that a person of ordinary skill “would look at the manufacturing tolerances and requirements for light sets and would adopt an approach that works for light sets.”); Ex. 1023<sup>5</sup>, 37:22–38:14, 60:21–61:8.

For the foregoing reasons, we are not persuaded that the level of ordinary skill in the art requires specific experience in the packaging of optoelectronic devices as is argued by Patent Owner. We also are not persuaded that the level of ordinary skill in the art requires education in the form of a Master Degree in Material Sciences, Electrical Engineering, or Mechanical Engineering, as is argued by Patent Owner. Instead, we are persuaded by Petitioner’s statement of the level of ordinary skill in the art, and our finding of the level of ordinary skill is similar to that proposed by Petitioner, but with a slight modification, i.e., that a basic level of technical education is required, at the level of an Associate Degree (two year college program) in Physics, Electrical Engineering, Mechanical Engineering, or Industrial Engineering.

We find that the level of ordinary skill in the art is that of one having at least an Associate Degree or Bachelor’s Degree in Physics, Mechanical Engineering, Electrical Engineering, or Industrial Engineering, plus 1–4 years of working experience with semiconductor electronic device packaging or printed wiring board assembly. A more advanced degree would be paired with a shorter period of working experience.

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<sup>5</sup> Exhibit 1023 has two sets of page numbers. For purposes of this Decision, we refer to the bottom-most page number in the lower right corner of the document. This number appears in the form of Page X of 132.

*B. Expert Testimony*

Patent Owner did not specifically file a motion to exclude Dr. Pugliandla's testimony as inadmissible, but requests, in its Response, that we "give little, if any, weight to Dr. Puligandla's testimony" (PO Resp. 18 (citing Ex. 1002) because he "does *not* have experience in the packaging of light-emitting diodes, in optoelectric packaging, in optic packaging or in light strings" (*id.* at 16). Patent Owner contends that as a result of this lack of experience "Dr. Pugliandla reached several erroneous conclusions." *Id.* at 17.

Patent Owner specifically describes only one alleged error in Dr. Pugliandla's deposition testimony—that glass is commonly used as transparent material to encapsulate LEDs. *Id.* (citing Ex. 2002, 38:11–14, 40:4–6). Dr. Denbaars testifies to the contrary, without pointing to supporting evidence, that "[i]n fact, LED's are never encapsulated in glass because the thermal mismatch and strain would crack the LED chip during thermal cycles." Ex. 2001 ¶ 39. Patent Owner also asserts that a person of ordinary skill "in the area of optoelectronics must consider issues associated with how light is transmitted, diffracted, reflected, and the like." *Id.*

Patent Owner has not articulated a persuasive reason for giving Dr. Pugliandla's testimony little or no weight. Petitioner submits other evidence contrary to Dr. Denbaars unsupported assertion that LED's are *never* encapsulated in glass. Reply 8 (citing Ex. 1022). For example, Exhibit 1022 is a journal article, dated 2006 and titled "Optical characteristics of spherical glass encapsulated LEDs." Ex. 1022, Title. Moreover, as discussed above, we are not persuaded that a person of ordinary skill in the art of the '978 patent would be required to have specific experience in the packaging of

optoelectronic devices as opposed to electronic packaging in general. We are, thus, not persuaded that Dr. Pugliandla's answers, during deposition, to two questions about the material used for transparent encapsulation is wrong or that the entirety of his testimony should be given little or no weight based on this disagreement.

In fact, Dr. Pugliandla is highly qualified in the area of electronic packaging. Dr. Pugliandla has several degrees, including a Ph.D. in chemistry. Reply 8–9; Ex. 1002 ¶ 9. He spent many years working in the areas of electronic packaging and surface mount technology, has taught courses in electronic packaging, and has served as a member of the Board of Directors for the National Surface Mount Technology Association. *Id.* at ¶¶ 12–18. We are persuaded that Dr. Pugliandla's education and experience is relevant to the issues discussed in the '978 patent. Moreover, given the subject matter of the '978 patent and Dr. Pugliandla's experience in electronic packaging, we do not find his admitted lack of direct experience in optoelectronic device packaging (*see* Ex. 2002, 38:15–22) as basis to accord his testimony little or no weight. On this record, we still credit the testimony of Dr. Pugliandla over the contrary testimony of Dr. Stephen P. Denbaars (Dr. Denbaars)<sup>6</sup> about whether glass is commonly used as transparent material to encapsulate LEDs or never used to encapsulate LED. An expert does not have to have direct hands-on design experience on a subject to know what existed as a common technique on that subject.

Under 37 C.F.R. § 42.1(d), we apply the preponderance of the evidence standard in determining whether Petitioner has established

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<sup>6</sup> Ex. 2001.

unpatentability. In doing so, it is within our discretion to determine the appropriate weight to be accorded the evidence presented, including expert opinion, based on the disclosure of the underlying facts or data upon which that opinion is based. Thus, we decline to make a determination about Dr. Pugliandla's opinion, as a whole. Rather, in our analysis we will consider, as it arises, relevant portions of Dr. Pugliandla's testimony and determine the appropriate weight to accord that particular testimony.

*C. Claim Construction*

We construe all terms, whether or not expressly discussed here, using the broadest reasonable construction in light of the '978 patent specification. 37 C.F.R. § 42.100(b). For purposes of the Institution Decision, we expressly construed the following terms: (1) "contact-pad area" as "an opening in an insulating layer of a conducting wire where electrical contact can be made"; and (2) "encapsulating" as "enclosing." Decision 8–15. In the post-institution briefs, Patent Owner disputes only the construction of "encapsulating." For purposes of this decision, therefore, we continue to apply the construction of "contact-pad area" as set forth above and we address the construction of the term "encapsulating" below. We construe all other terms using the broadest reasonable construction in light of the '978 patent specification.

Patent Owner asserts that the broadest reasonable interpretation of the term "encapsulating" in view of the '978 specification "requires the transparent packages to fully encapsulate the pair of contact pad areas on the conducting wires, as well as the surface mounted light-emitting component." PO Resp. 11. Patent Owner, thus, proposes that "'encapsulation' be construed to mean enclosure on all sides of the surface mounted light-

emitting component and the pair of first and second contact-pad areas.” PO Resp. 15. In fact, although not expressly articulated in its proposed claim construction, Patent Owner would actually require that “encapsulation” requires that the enclosure on all sides be made using encapsulating material. For example, Patent Owner argues that Lin-US is not encapsulated because the components to be encapsulated are mounted on a backing. PO Resp. 33 (“[w]hile Lin-US describes the use of an epoxy resin to cover the LED die and wire bonded assembly, it does not teach the complete enclosure of the assembly.”); *see also* Paper 10 (“Prelim. Resp.”), 12–14 (“Lin-US is a lamp on a backing that would not even be exposed to the mechanical impacts of the light string of the ’978 Patent.”).

We do not agree with Patent Owner’s proposed definition for encapsulation—“enclosure on all sides of the surface mounted light-emitting component and the pair of first and second contact-pad areas.” We also do not agree that encapsulation should be construed so narrowly as to require the enclosure to be composed solely of encapsulation material.

First, claim 1, itself, recites “encapsulating every pair of first and second contact-pad areas on the first and second conducting wires and the surface mounted light emitting component bonded thereto.” Patent Owner’s proposal to include “the surface mounted light-emitting component and the pair of first and second contact-pad areas” in the construction of “encapsulating” would incorporate features already recited in the claims, making them redundant. *See Apple v. Ameranth*, 2016 WL 6958650, \*3 (Fed. Cir. Nov. 2016).

Thus, the only relevant question is whether we should append the phrase “on all sides” to our construction. We are not persuaded that

encapsulating components requires that each and every side of the components be surrounded by encapsulating material. In other words, when only a subset of surfaces of a device is exposed to the environment, the plain and ordinary meaning of encapsulate would include covering only those exposed surfaces with encapsulating material. The '978 patent supports this understanding by describing the process of encapsulating the components in Figure 6 as “a layer of transparent package 5 is further applied to *an outer side* of every paired first and second contact-pad areas 13, 23 on the first and second conducting wire 1, 2 and the surface mounted light emitting component 3 bonded thereto . . . .” Ex. 1001, 4:63–5:15 (emphasis added).

This understanding is also consistent with the '978 patent's stated goal of encapsulation, preventing the components “from electrically contacting with an external environment,” “protect[ing] the surface mounted light emitting components 3 against failure due to contacting with external dust and particles,” and strengthening the connections by “protecting . . . against damage and separation . . . due to external impact.” *Id.* Ex. 1002 ¶ 46 (“The use of encapsulating materials to [improve the ruggedness and reliability] is a common practice in the electronic assembly industry, and was commonly practiced for decades prior to the critical date of the '978 patent.”); *see also*, Ex. 2001 ¶¶ 65–67 (Dr. Denbaars testifying that without full enclosure, a device would not be protected from the environment); Ex. 2002, 46:4–19 (Dr. Puligandla testifying similarly). The relevant components are fully protected from the external environment when the surfaces exposed to such environment are covered by encapsulating material.

We, therefore, continue to give the term “encapsulating” its plain and ordinary meaning: enclosing the exposed surfaces of the recited components.



We do not construe the term encapsulating, however, to require covering all component surfaces by encapsulating material.

*D. Overview of Popovich*

Popovich discloses a light emitting diode (LED) strip lamp. Ex. 1012, Title. The lamp contains a current supplying conductor composed of a metal wire rod with a painted insulating layer. *Id.* at Abs. The shaped electrode of an LED is “fixed directly to a diode connecting part on [the] current supplying conductor, by die bonding or other fixing means,” in places where the insulating painted layer is absent. *Id.*

Popovich discloses several embodiments of the LED strip. *See, e.g.,* Ex. 1012, 2:10–28 (describing figures showing seven embodiments of the invention). The first embodiment is shown in Figures 1, 2, and 3. Figures 1 and 2 are reproduced below.

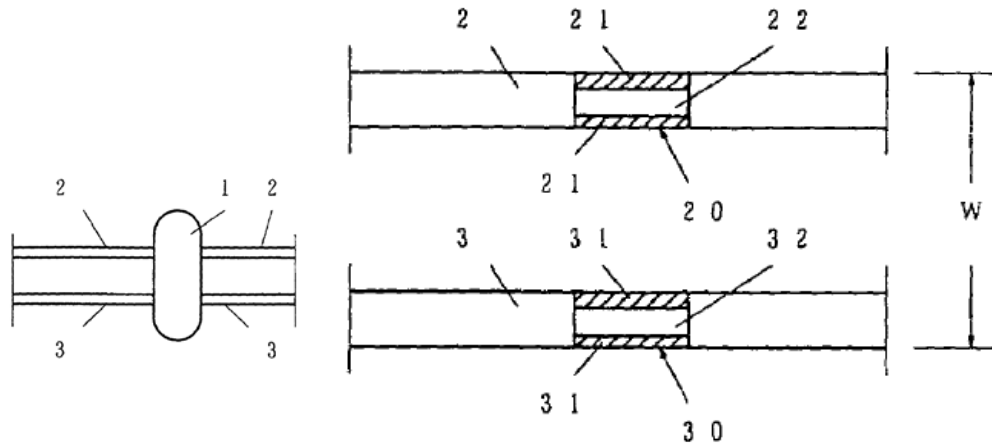


Figure 1 of Popovich, above left, shows insulating paint coated wires 2, 3 connected to LED 1. *Id.* at 4:35–41. Figure 2, above right, details insulating paint layers 21, 31, which are removed at connecting parts 20, 30, exposing top surface of conducting wires 22, 32 enabling connection to extruded electrodes 11, 12 of LED 1 “by die bonding.” *Id.* at 4:42–5:2.

The second embodiment of Popovich is depicted in Figures 5 and 6, reproduced below. *Id.* at 2:16–18.

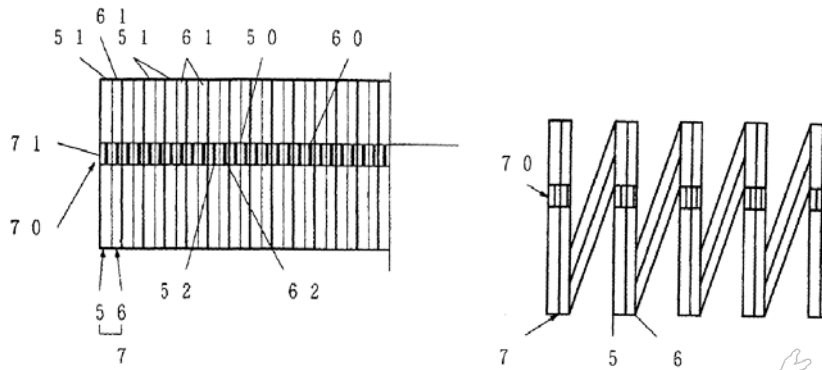


Figure 5, above left, shows two current supplying conductors 5, 6 aligned and joined together to form cable 7. *Id.* at 5:52–56. Cable 7 is wound into a tube-shaped helical wire with a straight line of grooves or notches 71, with insulating paint layer portions 51, 61 exposing the inside of conducting wire 52, 62, exposed parts 50, 60 connected to a mounting part or parts of the LED. *Id.* at 5:56–6:5.

#### *E. Overview of Lin-US*

Lin-US discloses a method of manufacturing continuous strips of lamps, including LED lamps. Ex. 1016 ¶ 5–8. In a first embodiment, a laminator presses a continuous strip 20 that includes a conductor assembly made up of two conducting foil wires sandwiched between insulating strips. *Id.* ¶ 20. Periodic equally-spaced pairs of holes are formed on the upper insulating strip to expose two conducting foil wires. *Id.* Surface-mount device light emitting diodes (SMD LEDs) are mounted across these holes to form a continuous strip of lamps. *Id.* In a second embodiment, LED

“dice,”<sup>7</sup> as opposed to SMD LEDs, are bonded to the foil wires. *Id.* ¶ 22.

The description of this second embodiment includes a further step of sealing the LED dice using a layer of epoxy resin. *Id.*

Figure 5 of Lin-US is reproduced below.

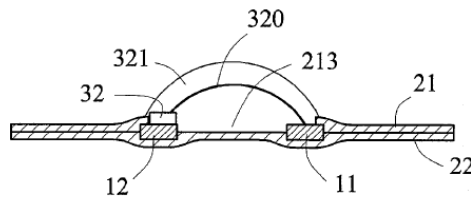


FIG. 5

Figure 5, above, is a cross-sectional view of a lamp created using the second embodiment. *Id.* ¶ 14. A “layer of epoxy resin 321 is sealed and covered on LED dice bonding 32, aluminum wire 320, and large hole 213.” *Id.* ¶ 22

*F. Overview of Lin-CN*

Lin-CN is a Chinese patent application publication (the named inventor, Hsi Huang Lin, is unrelated to the named inventor of Lin-US, Yuan Lin). Ex. 1019. This publication discloses a “method for the parallel connection and encapsulation of light-emitting semiconductor dies.” *Id.* at Abs. Figure 5, reproduced below, shows one stage of an embodiment.

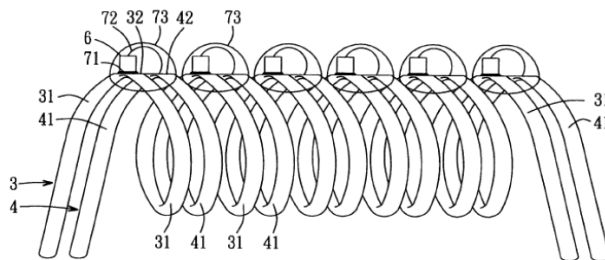


Figure 5

<sup>7</sup> “Dice” are cut semiconductor wafers (individually a “die”) upon which a functional circuit is fabricated.

Figure 5, above, shows electrical conductors 3, 4 wound parallelly around a cylinder 5 (not shown), forming a plurality of conductive rings 31, 41. *Id.* at 10. Each conductive ring includes a flattened surface 32, 42 linearly arranged axially along cylinder 5. *Id.* Light-emitting semiconductor dies are connected to flattened surface 32 using “silver conductive adhesive 71” and wire conductor 72 connects the LED die to respective flattened surface 42. *Id.* at 10–11. Finally, die 6, flattened surface 32, wire conductor 72, and flattened surfaces 32 and 42 are encapsulated by transparent insulator 73. *Id.* at 11. Transparent insulator 73 “can be formed by glue dispensing, glue soaking or molding.” *Id.*

Figure 6, reproduced below, shows another stage of this embodiment.

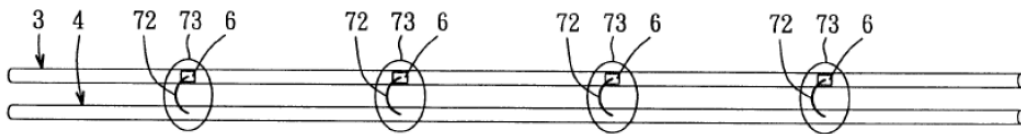


Figure 6

Figure 6, above, shows electrical conductors 3, 4 with wire conductor 72 and transparent insulator 73. *Id.*

### *G. Obviousness Analysis*

#### *1. Popovich and Lin-US*

Petitioner asserts that a person of ordinary skill in the art would have found the challenged claims obvious over the combination of Popovich and Lin-US and the combination of Popovich, Lin-US, and Lin-CN. Pet. 32–39, 49–59 (citing Ex. 1002). In particular, Petitioner asserts that Popovich discloses every limitation of claim 1 of the '978 patent except that it does not “expressly disclose application of a material to encapsulate the LED components and their respective wire conductors.” Pet. 33, 51. In other

words, Petitioner concedes that Popovich does not expressly disclose “a plurality of transparent packages encapsulating every pair of first and second contact-pad areas,” (“the transparent packages limitation”). *Id.* at 33.

Petitioner relies on Lin-US for teaching the transparent packages limitation. *Id.* at 33, 37, 51, 56.

We agree with and adopt Petitioner’s analysis and determine that Petitioner has shown, by a preponderance of the evidence, that Popovich discloses all the limitations of independent claim 1 except the transparent packages limitation, which would have been obvious to add to Popovich’s device based on Lin-US’s disclosure of such encapsulation and the person of ordinary skill in the art’s desire to provide mechanical and electrical protection of the lighting components. We have reviewed both parties’ arguments and supporting evidence, including the disclosure of both references and the testimony of Dr. Puligandla and Dr. Denbaars. Pet. 32–39; PO Resp. 18–38; Reply 9–23; Ex. 1002; Ex. 2001. For the reasons discussed below, we do not agree with Patent Owner’s arguments to the contrary.

- a. *“via a conductive paste sandwiched between respective first and second leads and said first and second conducting wires”*

For disclosure of this limitation, Petitioner relies on Popovich’s description of a lighting device as shown in Figures 1 and 3. Pet. 36 (citing Ex. 1012, 4:48–61, Figs. 1, 3; Ex. 1002 ¶¶ 33–38, 63, 67, 68, 106).

According to Petitioner, Popovich discloses “the electrodes are bonded to the contact-pad areas using conductive paste sandwiched therebetween.” *Id.*

Patent Owner argues that Petitioner has not met its burden to show the use of “conductive paste sandwiched between” leads and conducting wires

(“the conductive paste limitation”). PO Resp. 21–34; Tr. 20:12–17.

Specifically, Patent Owner focuses on an alleged inventive movement from solder (used in the prior art) to conductive paste, for attaching an SMD to conductive wires as recited in the claims. *See, e.g.*, PO Resp. 28 (“None of the references discloses a movement from solder to conductive paste to solve a problem in the art.”), 21–30. According to Patent Owner “[b]ecause the prior art discloses the use of *soldering to bind an SMD to conductive wires* and does not identify any problem that needed to be solved as a result of soldering, the use of conductive paste for such a bond is a novel feature of claim 1 of the ’978 patent.” PO Resp. 29.

Patent Owner asserts that Popovich discloses the use of solder and does not mention any “problems with the use of soldering” or substituting conductive paste for soldering. PO Resp. 21. Moreover, Patent Owner contends that Popovich’s reference to using “die bonding or other fixing means” to attach an LED “to a diode connecting part on a current supplying conductor” (Ex. 1012, Abs., 2:56–58), refers to the use of conductive paste only for attaching a die to a surface mounted device (“first level packaging”), but not for attaching a surface mounted device to the conductive wires (“second level packaging”). PO Resp. 31 (citing Ex. 2001 ¶¶ 57–58); *see also* Tr. 21:1–16 (explaining first and second level packaging). Patent Owner concludes that “the die bonding for first level packaging disclosed in Popovich is not relevant to the claims of the ’978 patent and cannot serve as a basis for invalidating those claims.” PO Resp. at 31.

As for Lin-US, Patent Owner asserts that it “is silent with respect to how the SMD LED 21 is mounted across the pair of holes 210” and

Petitioner's acknowledgment that solder was among the choices available for bonding shows that solder is what a person of ordinary skill would have used. PO Resp. 24–25.

Despite Patent Owner's arguments to the contrary, we find a preponderance of the evidence shows that a person of ordinary skill would have found it obvious to use conductive paste to attach a surface mounted device to the conductive wires as claimed. Popovich explicitly discloses the use of “die bonding or other fixing means.” Ex. 1012, 2:56–58. And Patent Owner agrees that “[c]onductive paste has been used to attach a die to a surface mounted device . . . for many years.” PO Resp. 31; Tr. 27:8–14 (“Patent Owner does not dispute the presence of conductive paste in first-level packaging that has been around since the 1970s.”); Ex. 2002, 57:5–18; Ex. 1023:73:23–74:3.

Moreover, the evidence shows that a person of ordinary skill in the art would have found it obvious to use conductive paste to attach an SMD to conducting wires (second-level packaging) based on the disclosure of both Popovich and Lin-US. Dr. Puligandla specifically states that “[u]se of conductive adhesives for second level packaging . . . has also been in common use since at least the 1980's.” Ex. 1002, ¶ 35. Dr. Puligandla describes why conductive adhesives came into use at that particular time, and thoroughly explains the different types of conductive adhesives along with how and why they work. *Id.* ¶¶ 35–38; ¶ 68. In addition, Popovich specifically refers to using “die bonding or other fixing means” to attach an LED “directly to the diode connecting part on the current supplying conductor.” Ex. 1012, 2:56–58. Thus, even if die bonding usually refers to first-level packaging, in Popovich, it clearly is directed to attaching an LED

to conducting wires. At oral hearing, Patent Owner agreed with this reading of Popovich.

JUDGE LEE: Counsel, given that Popovich does not disclose a surface mount for the LED as you just verified two minutes ago, your proposed distinction between level 1 and level 2, manner of connection, really has no support on this record, right, because Popovich discloses exactly what your claim requires . . . die bonding to connect LED directly to the underlying wires; is that correct?

MR. MEHTA: Yes, Your Honor, for those claim elements.

. . .

JUDGE LEE: Popovich is showing no surface mounts. A level 1 is irrelevant in the context of Popovich. . . . Do you want to just make it easy for everyone and withdraw the proposed distinction between level 1 and level 2, and instead we can just focus on whether it would have been obvious to use a conductive paste, given the disclosure of die bonding?

MR. MEHTA: Yes, Your Honor, I will withdraw that.

Tr., 35:21–37:11.

Accordingly, we find a preponderance of the evidence shows a person of ordinary skill would have found the conductive paste limitation obvious based on the teachings of Popovich and Lin-US.

*b. transparent packages limitation*

Petitioner relies on Lin-US’s description of the application of epoxy resin as a transparent package over each mounted LED component and respective first and second contact-pad areas to encapsulate the components. Pet. 37 (citing Ex. 1016 ¶ 22; Ex. 1002 ¶¶ 82, 107–108).

Patent Owner argues that Petitioner has not met its burden to show the transparent packages limitation. PO Resp. 21–34; Tr. 20:12–17. Patent Owner asserts that “[w]hile Lin-US describes the use of an epoxy resin to cover the LED die and wire bonded assembly, it does not teach the complete



enclosure of the assembly.” PO Resp. 33. According to Patent Owner, “FIG. 5 of Lin-US plainly shows the epoxy resin covering only the top of the LED-wire bonded device” and thus, “it would not prevent environmental elements from getting into the device, which is one of the primary concerns addressed by the ’978 patent.” Ex. 2001 ¶¶ 66–67.

Petitioner, on the other hand, argues that in Lin-US “the encapsulation material is a transparent epoxy resin that is used to enclose the aluminum wire bond and also cover the totality of the hole pair in the top foil surface.” Ex. 1002 ¶ 82. Dr. Pugliandla supports this position, stating that “[t]he use of epoxy resin encapsulant materials to insulate and protect electrical devices against electrical shorting, physical damage, and to provide robustness against environmental concerns was well known and understood in the electronics industry prior to Lin-US.” *Id.*

Despite Patent Owner’s arguments to the contrary, we conclude that Lin-US discloses the use an epoxy or silicon resin to encapsulate (as we have construed this term above) with a transparent package, each bonded LED device. There is no dispute that encapsulating materials were known at the critical time and that such materials were known to provide benefits of mechanical and environmental protection for electrical devices. Ex. 1002 ¶ 82; Ex. 1023 47:16–48:8. And we find no credible evidence to support Patent Owner’s theory that because Figure 5 of Lin-US shows the epoxy layer extending only to upper strip 21, that the layer does not fully enclose, or encapsulate the contact-pad areas and the SMD LED. In fact, Lin-US explicitly states that “a layer of epoxy resin 321 is *sealed* and covered on LED dice bonding 32, aluminum wire 320, and large hole 213.” Ex. 1016 ¶ 22 (emphasis added). We agree with Petitioner that this disclosure teaches

the epoxy resin material encapsulates the contact pad areas and the LED component. *See* Reply 16; *see also* Ex. 2002, 80:18–81:18 (Dr. Puliglandla testifying “I would assume the epoxy is in liquid form, and therefore I would assume there won’t be any air gap in there.”).

*c. combination of Popovich and US-Lin*

Petitioner asserts that the combination of the transparent packages taught by Lin-US with the LED lamp disclosed by Popovich would have been a simple substitution of one known element for another to obtain predictable results. *Id.* at 32. Specifically, Petitioner explains that: (1) both Popovich and Lin-US describe LED lamps created with similar construction methods; (2) the components, compounds, and techniques used in both references would have been well known and understood by a person of ordinary skill at the time of the invention; (3) the substitution of various components of the references would have been simple and would have given predictable results; and (4) the use of encapsulation, as taught by Lin-US, to improve reliability of LED light strings was well-known and commonly performed in industry. *Pet.* 32–33 (citing Ex. 1002 ¶¶ 62–69, 76–84, and 101–111).

In response, Patent Owner argues that a person of ordinary skill would not have had a rationale to combine Popovich and Lin-US. *PO Rep.* 18–30. According to Patent Owner, Petitioner merely asserts, without proper reasoning, the conclusion that a person of ordinary skill would have combined the references. *Id.* at 20. Patent Owner’s arguments on this issue mainly incorporate the arguments addressed above, that neither Popovich nor Lin-US discloses the conductive paste limitation or the transparent

package limitation. PO Resp. 18–38. As discussed above, we do not agree with Patent Owner on these issues.

In addition, Patent Owner argues that excessive heat buildup in the combined light set of Popovich and Lin-US shows that (1) the combination would not have furthered the heat dissipation objective of Popovich (PO Resp. 25), and (2) the combination would not work as intended (*id.* at 26).

We agree with Petitioner that a person of ordinary skill in the art would have found obvious adding the transparent encapsulating package of Lin-US to the light set of Popovich, ending up with the claimed subject matter. Lin-US describes encapsulating the LED component and conducting wires and, as we noted, the evidence shows a person of ordinary skill in the art would have known such encapsulation to provide benefits of mechanical and environmental protection for electrical devices. Ex. 1002 ¶ 82; Ex. 1023 48:16–49:8

The evidence does not support Patent Owner’s assertion that the combination of Popovich and Lin-US would not work as intended because of excessive heat buildup. Patent Owner asserts that the claimed light sets “are supposed to last for something like 10,000 hours” and the light set created by the combination of Popovich and Lin-US “wouldn’t last more than 100 hours.” Tr. 34:1–8. Petitioner concedes that the device may have a shortened lifetime, but argues that the device would still work. Reply 20 (citing Ex. 1023, 35:10–14, 48:19–25). Petitioner adds that, in fact, operating time may or may not be an issue depending upon the device specifications. *Id.* We agree with Petitioner that a preponderance of the evidence shows that combining the encapsulation feature of Lin-US with the light set of Popovich would, indeed, work as intended. Ex. 1002 ¶¶ 107–11;

Ex. 1023, 35:10–14; Tr. 33:12–34:14. There is no requirement in the claims that the device would operate for close to 10,000 hours.

We are also not persuaded by Patent Owner’s argument that Popovich and Lin-US have different objectives that would deter a person of ordinary skill in the art from combining their teachings. First, Popovich explicitly states that an intended purpose is “improved production methods” of LED strip lamps (Ex. 1012, 1:9–13), which is also the stated objective of Lin-US—“a novel method of manufacturing a desirable lamp on sheet” (Ex. 1016 ¶ 4). Moreover, even assuming the combined light set results in higher heat buildup, a combination of references may be obvious even if the combination eliminates a benefit of one of the references. For example, in *In re Urbanski*, 809 F.3d 1237 (Fed.Cir.2016), the Federal Circuit affirmed the Board’s determination that one of ordinary skill would have reason to combine two references having benefits that were “mutually exclusive,” because a skilled artisan may seek the benefit of one of the references at the expense of the other reference’s benefit. *Id.* at 1242. Here, too, we are persuaded that one of ordinary skill would have proceeded with the combination of Popovich and Lin-US to achieve the known benefits of mechanical and environmental protection.

*d. Claims 2 and 3*

Petitioner asserts that a person of ordinary skill in the art would have found claims 2 and 3 of the ’978 patent obvious over the combination of Popovich and Lin-US. Pet. 32–39 (citing Ex. 1002). In particular, Petitioner asserts that Popovich discloses claim 2’s limitation “wherein the conductive paste is silver” and claim 3’s limitation “wherein the second conducting wire is disposed parallel adjacent to the first conducting wire.” Pet. 38–39 (citing

Ex. 1012, 2:50–67, 4:55–61, 5:3–7, 7:4; Ex. 1002 ¶¶ 33–38, 62, 63, 65, 68, 69, 103, 111)

We agree with and adopt Petitioner’s analysis and determine that Petitioner has shown, by a preponderance of the evidence, that Popovich discloses all the limitations of challenged claims 2 and 3 except the transparent packages limitation, which would have been obvious to add to Popovich’s device based on Lin-US’s disclosure of such encapsulation and the person of ordinary skill in the art’s desire to provide mechanical and electrical protection of the lighting components. We have reviewed both parties’ arguments and supporting evidence, including the disclosure of both references and the testimony of Dr. Puligandla and Dr. Denbaars. Pet. 38–39; PO Resp. 18–38; Reply 9–23; Ex. 1002; Ex. 2001.

Patent Owner relies on the arguments above, regarding independent claim 1, to argue patentability of dependent claims 2 and 3. PO Resp. 38. For the reasons discussed above, we agree with Petitioner that a preponderance of the evidence shows claims 2 and 3 would have been obvious in view of the combined teachings of Popovich and Lin-US.

## 2. *Popovich, Lin-US, and Lin-CN*

Petitioner asserts that a person of ordinary skill in the art would have found the challenged claims obvious over the combination of Popovich, Lin-US, and Lin-CN. Pet. 49–59 (citing Ex. 1002). In particular, Petitioner asserts that Popovich discloses every limitation of the challenged claims except that it does not disclose the transparent packages limitation. *Id.* at 51–56. Petitioner relies on Lin-US and Lin-CN for teaching the transparent packages limitation. *Id.*

We agree with and adopt Petitioner's analysis and determine that Petitioner has shown, by a preponderance of the evidence, that Popovich discloses all the limitations of challenged claims 1–3 except the transparent packages limitation, which would have been obvious to add to Popovich's device based on both Lin-US's and Lin-CN's disclosure of such encapsulation and the person of ordinary skill in the art's desire to provide mechanical and electrical protection of the lighting components. We have reviewed both parties' arguments and supporting evidence, including the disclosure of both references and the testimony of Dr. Puligandla and Dr. Denbaars. Pet. 49–60; PO Resp. 18–38; Reply 9–23; Ex. 1002; Ex. 2001. For the reasons discussed below, we do not agree with Patent Owner's arguments to the contrary.

Patent Owner makes the same arguments for patentability regarding the addition of the teachings of Lin-CN to those of Popovich and Lin-US. We find that Lin-CN only strengthens the case of obviousness here. As recognized by Patent Owner, Lin-CN not only explicitly describes using conductive paste, it describes silver conductive paste as recited in claim 2 of the '978 patent. Ex. 1019, 10 (“[Electrically glue the plurality of light-emitting semiconductor dies 6 onto the flattened surfaces 32 of the plurality of first conductive rings 31 respectively with silver conductive adhesive 71.”); Ex. 1023, 97:22–98:17). Further, Figure 6 of Lin-CN shows transparent insulator 73, itself, enclosing all sides of the LED, the contact pads, and the wire conductor 72. Ex. 1019, 11. Finally, we agree with Petitioner that a person of ordinary skill in the art would have looked to the teachings of both Lin-US and Lin-CN to add a transparent package to encapsulate the LED component and associated wires in the light set

disclosed by Popovich. Both Lin-US and Lin-CN themselves describe the beneficial effects of this encapsulation. *See* Pet. 33; Ex. 1016 ¶ 22, Figs. 5–7; Ex. 1019, 11, Fig. 5; Ex. 1002 ¶¶ 77–78, 82, 107–108.

### III. CONCLUSION

Petitioner has shown, by a preponderance of the evidence, that the challenged claims would have been obvious over the combination of Popovich and Lin-US, and Popovich, Lin-US, and Lin-CN.

Accordingly, it is

ORDERED that claims 1–3 of the '978 patent are determined to be *unpatentable*;

FURTHER ORDERED that because this is a final written decision, parties to the proceeding seeking judicial review of the decision must comply with the notice and service requirements of 37 C.F.R. § 90.2.

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