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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

Ex parte TING LI and THOMAS YUAN

Appeal 2017–001234
Application 14/514,158
Technology Center 2800

Before TERRY J. OWENS, WESLEY B. DERRICK, and CHRISTOPHER L. OGDEN, *Administrative Patent Judges*.

OGDEN, *Administrative Patent Judge*.

DECISION ON APPEAL

Appellant[1] appeals under 35 U.S.C. § 134(a) from the Examiner's final decision rejecting claims 1–20 in the above-identified application.[2] We have authority pursuant to 35 U.S.C. § 6(b). We reverse.

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[1] Appellant is the Applicant, Luminus Devices, Inc., which according to the Appeal Brief is the real party in interest. Appeal Brief 1, Jan. 29, 2016 [hereinafter Appeal Br.].

[2] The appeal record includes Final Office Action, Oct. 22, 2015 [hereinafter Final Action]; Appeal Br.; Examiner's Answer, Aug. 9, 2016 [hereinafter Answer]; Reply Brief, Oct. 18, 2016 [hereinafter Reply Br.].

BACKGROUND

Appellant's invention relates to a light emitting diode structure comprising two semiconductor structures bonded without any adhesive using a layer of nanoparticles. *See* Appeal Br. 2–5. Independent claim 1, which represents the subject matter in dispute, reads as follows:

> 1. A light emitting diode structure comprising:
> a first III-V semiconductor structure comprising a first light emitting layer disposed between a first n-type region and a first p-type region;
> a second III-V semiconductor structure comprising a second light emitting layer disposed between a second n-type region and a second p-type region;
> a first contact formed on a top surface of the first III-V semiconductor structure;
> a second contact formed on a bottom surface of the second III-V semiconductor structure; and
> a layer of nanoparticles disposed between the first and second III-V semiconductor structures, *wherein the first and second III-V semiconductor structures are wafer bonded together using the layer of nanoparticles without any adhesive*.

Appeal Br. 22 (emphasis of key limitation added). Method claim 7 and apparatus claim 15, the only other independent claims, are directed to using a layer of nanoparticles to bond two semiconductor structures and the bonded structure, respectively. *See id.* at 23, 25.

The Examiner maintains the following rejections:

1. Claims 1, 2, 5, 7, 10, 11, 13, 15, 18, and 20 are rejected under 35 U.S.C. § 103 as being unpatentable over Heidborn[3] in view of Barnes.[4] *See* Final Action 2–7.

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[3] Heidborn et al., US 2009/0309120 A1 (published Dec. 17, 2009).
[4] Barnes et al., US 2010/0059776 A1 (published Mar. 11, 2010).

2. Claims 3 and 19 are rejected under 35 U.S.C. § 103 as being unpatentable over Heidborn in view of Barnes and Nishikawa.[5] *See id.* at 7–8.

3. Claim 4 is rejected under 35 U.S.C. § 103 as being unpatentable over Heidborn in view of Barnes, Nishikawa, and Sakizadeh.[6] *See id.* at 8–9.

4. Claims 6 and 12 are rejected under 35 U.S.C. § 103 as being unpatentable over Heidborn in view of Barnes and Kwak.[7] *See id.* at 9–10.

5. Claims 8 and 9 are rejected under 35 U.S.C. § 103 as being unpatentable over Heidborn in view of Barnes and Sung.[8] *See id.* at 10–12.

6. Claims 14 and 16 are rejected under 35 U.S.C. § 103 as being unpatentable over Heidborn in view of Barnes and Srinivas.[9] *See id.* at 12–13.

7. Claim 17 is rejected under 35 U.S.C. § 103 as being unpatentable over Heidborn in view of Barnes and Sakizadeh. *See id.* at 13–14.

DISCUSSION

The Examiner finds that Heidborn teaches all the limitations of claim 1, except it does not teach that "the bonding agent is a layer of nanoparticles and the first and second III-V semiconductor structures are wafer bonded together using the layer of nanoparticles without any adhesive." Final

[5] Nishikawa et al., US 2002/0048729 A1 (published Apr. 25, 2002).
[6] Sakizadeh et al., US 2007/0072772 A1 (published Mar. 29, 2007).
[7] Kwak et al., US 2005/0087758 A1 (published Apr. 28, 2005).
[8] Sung et al., US 2005/0082556 A1 (published Apr. 21, 2005).
[9] Srinivas et al., US 2013/0000952 A1 (published Jan. 3, 2013).

Action 3. However, the Examiner finds that "Barnes teaches a bonding agent used with a[n] LED light source is formed from a layer of nanoparticles and bonding is performed using the layer of nanoparticles without any adhesives." *Id.* (citing Barnes ¶ 6). The Examiner then determines that substituting the nanoparticle bonding layer from Barnes into the structure of Heidborn would be "a simple substitution for the bonding agent of Heidborn as the substituted components and their functions were known in the art and the substitution would have yielded predictable results." *Id.*

Appellant argues that Barnes only teaches the use of a nanoparticle bonding layer between a semiconductor layer and an "optical element," which is not a semiconductor structure as recited in claim 1. *See* Appeal Br. 7–9. According to Appellant, the optical element "is an optical extractor that facilitates escape of light from inside the LED die." *Id.* at 7 (citing Barnes ¶ 6). In Barnes, according to Appellant, the bonding layer is made from nanoparticles "to provide a bonding layer that has a refractive index 'closely matched to that of the light emission surface of the LED die' to maximize light output." *Id.* at 11 (citing Barnes ¶ 45). Because the rationale for using the bonding layer in Barnes would not apply to bonding two semiconductor structures as described in Heidborn, Appellant argues that "there would have been no apparent reason to combine Heidborn and Barnes in the way claimed." *Id.*

Appellant also argues that the nanoparticle bonding layer in Barnes would not have been a simple substitution for the adhesive layer in Heidborn, because the method of forming the layer in Barnes is a complex process, and Barnes' teachings do not address Heidborn's concern for

improving charge carrier transfer between the two semiconductor structures. *See* Reply Br. 6–7.

We agree with Appellant that the Examiner has not shown that a person of ordinary skill in the art at the time of invention would have had reason to substitute a nanoparticle bonding layer for the adhesive in Heidborn. "[O]bviousness concerns whether a skilled artisan not only *could have made* but *would have been motivated to make* the combinations or modifications of prior art to arrive at the claimed invention." *Belden Inc. v. Berk-Tek LLC*, 805 F.3d 1064, 1073 (Fed. Cir. 2015).

The Examiner's findings on this record are not sufficient to show by a preponderance of the evidence that a skilled artisan would have been motivated to use the nanoparticle layer in Barnes, used for forming a low refractive index bond between an LED and an optical element, as a replacement for the adhesive in Figure 4 of Heidborn, used for mechanically and electrically connecting two semiconductor structures.

For the above reasons, we reverse the Examiner's rejection of claim 1 under 35 U.S.C. § 103. Because the Examiner's other rejections do not remedy the above issue, we also reverse the rejections of claims 2–20.

DECISION

The Examiner's decision is reversed.

REVERSED