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EXAMINER
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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

Ex parte BING-RUEY WU

Appeal 2015-004479
Application 12/415,139
Technology Center 2800

Before MARK NAGUMO, MICHAEL P. COLAIANNI, and DONNA M. PRAISS, *Administrative Patent Judges*.

PRAISS, *Administrative Patent Judge*.

DECISION ON APPEAL[1]

STATEMENT OF CASE

Appellant[2] appeals under 35 U.S.C. § 134 from the Examiner's decision to reject claims 1–3, 6, and 7 under 35 U.S.C. § 102(b) as

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[1] In this decision, we refer to the Specification filed March 31, 2009 (Spec.), the Final Office Action appealed from mailed January 13, 2014 (Final Act.), the Appeal Brief filed September 15, 2014 (App. Br.), the Examiner's Answer mailed January 5, 2015 (Ans.), and the Reply Brief filed March 5, 2015 (Reply Br.).

[2] The real party in interest is identified by Appellant as Agilent Technologies, Inc. App. Br. 3.

anticipated by Nguyen '253[3] and claims 8–13, 15, and 16 under 35 U.S.C. § 103(a) as obvious over Nguyen '185[4] and Moon.[5] Appellant does not argue under a separate heading the Examiner's rejection of claim 14 under 35 U.S.C. § 103(a) as obvious over Nguyen '185, Moon, and Van Zeghbroeck[6] as required by 37 C.F.R. § 41.37(c)(iv). *See* Final Act. 6. Therefore, we summarily affirm the rejection of claim 14.

We have jurisdiction under 35 U.S.C. § 6(b).

We AFFIRM the Examiner's rejection of claims 1–3 and 6–16 and designate the rejection of claims 1–3, 6, and 7 under 35 U.S.C. § 102(b) a new ground of rejection.

The claims are directed to a semiconductor device having a heterojunction. Claims 1 and 8 are illustrative (subject matter in dispute italicized):

> 1. A semiconductor device comprising a heterojunction, comprising:
>
> a first region comprising a first III-V semiconductor;
>
> a second region adjacent to the first region and comprising a second III-V semiconductor material, *the second III-V semiconductor material comprising a material of graded concentration over a width of the second region, wherein the material of graded concentration comprises a minimum concentration at [a] junction of the first III-V semiconductor and the second III-V semiconductor*; and
>
> a third region adjacent to the second region and comprising a third III-V semiconductor material, *the material of graded concentration comprising a maximum concentration at*

[3] Nguyen et al., US 2003/0032253 A1, published February 13, 2003 ("Nguyen '253").
[4] Nguyen et al., US 5,606,185, issued February 25, 1997 ("Nguyen '185").
[5] Moon, US 4,195,305, issued March 25, 1980.
[6] Van Zeghbroeck, Principles of Electronic Devices 1996.

> *[a] junction of the second III-V semiconductor and the third III-V semiconductor*, wherein the graded concentration is selected to provide substantially no conduction band discontinuity at a junction of the second region and the third region, or to provide a type I semiconductor junction at the junction of the second region and the third region.
>
> 8. A double heterojunction bipolar transistor (DHBT), comprising:
>
> a first region comprising a first III-V semiconductor;
>
> *a second region forming a first heterojunction with the first region and comprising $Al_xGa_{1-x}AsSb$ wherein the concentration of Al is a graded concentration over a width of the second region*; and
>
> a third region forming a second heterojunction with the second region and comprising a second III-V semiconductor, wherein the graded concentration is select[ed] to provide substantially no conduction hand discontinuity at a junction of the second region and the third region, or to provide a type I semiconductor junction at the junction of the second region and the third region..

Claims App'x at App. Br. 16, 17.

Appellant does not separately argue the patentability of dependent claims 2, 3, 6, 7, and 9–13, 15, and 16. App. Br. 7–8, 13. In accordance with 37 C.F.R. § 41.37(c)(1)(iv), claims 2, 3, 6, and 7 will stand or fall together with claim 1 and claims 9–13, 15, and 16 will stand or fall together with claim 8.

OPINION

Claim 1

Regarding claim 1, the Examiner finds that Nguyen '253 teaches the recited first, second, and third regions comprising III–V semiconductor material and that the second region has a graded concentration having a minimum concentration at one junction and a maximum concentration at the

other junction. Final Act. 2–3 (citing Nguyen '253 Fig. 6, ¶ 37). The Examiner specifically identifies regions 12a, 13, and 14 in Figure 6 of Nguyen '253 as the required first, second, and third regions of claim 1, respectively. *Id*. at 2. The Examiner also finds that the minimum concentration of region 13 is at the junction with the first III–V semiconductor material and the maximum concentration of region 13 is at the junction with the third III–V semiconductor material. *Id*. at 2–3.

Appellant contends that the Examiner's rejection of claim 1 is in error because "there is no description of a grading concentration that comprises a minimum concentration at junction of the first III-V semiconductor and the second III-V semiconductor, or grading concentration that comprises a maximum concentration at junction of the second III-V semiconductor and the third III-V semiconductor as specifically recited in claim 1." App. Br. 7 (emphasis omitted).

The Examiner responds that in Nguyen '253's double heterojunction bipolar transistor device shown in Figure 6,

> Layer **13** is a graded quaternary compound formed by continuously varying the y-parameter $In(_{P0.69}Sb_{0.31})yAs_{1-y}$ from 0 at the interface with layer **14** to 1 at the interface with layer **12a** (see Nguyen: paragraph 0037). As the chemical formula shows, the concentration of As will have a minimum [sic, maximum] at this junction of the first **12a** and the second **13** III-V semiconductors, and the concentration of As will have a minimum at this junction of the second **13** and third **14** semiconductors.

Ans. 3. Figure 6 is shown below:

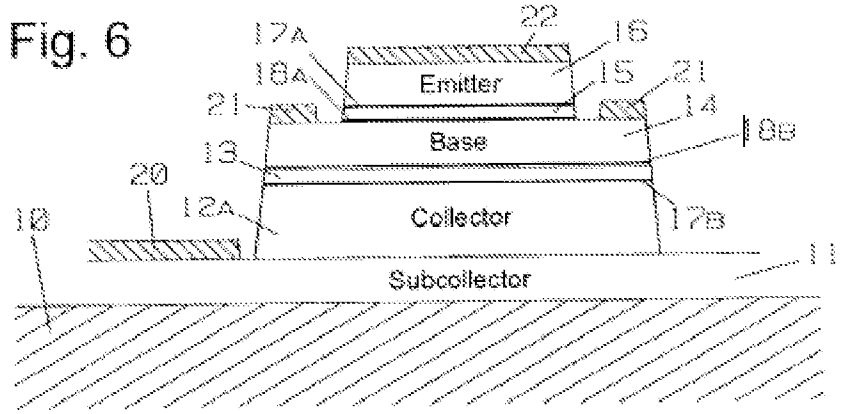

Figure 6 depicts a Sb-based double heterojunction bipolar transistor. Nguyen ’253 ¶ 13.

In the Reply Brief, Appellant argues that “there is no disclosure of a maximum concentration at junction of the second III-V semiconductor and the third III-V semiconductor, but rather at the junction of the first and third [sic, second] semiconductors, by the Examiner’s analysis.” Reply Br. 6–7 (emphasis omitted).

Appellant acknowledges that Nguyen’s second region 13 is a material of graded concentration having a minimum at one junction and a maximum at the other junction. We agree with Appellant that paragraph 37 of Nguyen ’253 describes the minimum concentration of the graded quaternary compound of region 13 as being at the junction of regions 13 and 12a and the maximum at the junction of regions 13 and 14. Reply Br. 6; Nguyen ’253 ¶ 37. Appellant does not dispute that each of Nguyen ’253’s regions 12a, 13, and 14 identified by the Examiner comprise a III-V semiconductor as required by claim 1. Based on the Examiner’s findings that Nguyen ’253 teaches (1) a double heterojunction bipolar transistor having three regions comprising III-V semiconductor material, (2) two junctions between the three regions, and (3) a second region between the first and third regions

having a graded concentration with a maximum at one junction and a minimum at the other junction, and the fact that claim 1 requires only that the location of the minimum and maximum concentrations are relative to the location of the three regions, we find that claim 1 is anticipated by Nguyen '253 where region 14 corresponds to the first region recited in claim 1, region 13 corresponds to the second region recited in claim 1, and region 12a corresponds to the third region recited in claim 1.

Because we recognize our decision is based in part on reasoning which differs from that advanced by the Examiner, we denominate the affirmed rejection of claims 1–3, 6, and 7 under 35 U.S.C. § 102(b) as a NEW GROUND OF REJECTION pursuant to 37 C.F.R. § 41.50(b).

Claim 8

Appellant contends that the Examiner's rejection of claims 8–13, 15, and 16 over Nguyen '185 and Moon is in error because "Moon fails to disclose grading of an aluminum concentration in $Al_xGa_{1-x}AsSb$ over a width of a region of a DHBT. Moreover, while Moon discloses growth of mismatched layers of GaAsSb through substitutional Al, the reference fails to disclose grading of an aluminum concentration in $Al_xGa_{1-x}AsSb$ over a width of a region of a DHBT as specifically recited in claim 8." App. Br. 11–12 (emphasis omitted). Appellant further asserts that the substitution of Al for Ga in Moon is not a disclosure of "variant Al concentration." *Id.* at 12 (emphasis omitted).

The Examiner responds that Nguyen '185 discloses a graded semiconductor layer formed between III-V semiconductor layers, but fails to teach that the graded layer is an AlGaAsSb alloy layer. Ans. 4 (citing Nguyen '185 4:45–66, Fig. 4). The Examiner also finds that Moon teaches

AlGaAsSb as a quaternary alloy system for use in heterojunction devices and gradually varying lattice constant to match unequal lattice constants of differing materials. *Id.* (citing Moon 1:15–20). The Examiner further finds "Moon teaches that grading aluminum AlGaAsSb layer would allow a lattice grading between two unequal lattice constants layers to have reproducible control of the lattice constant and band gap energy of the AlGaAsSb layer, thereby controlling the efficiency of the device[.]" *Id.* at 5 (citing Moon 1:14, 2:1–7). The Examiner also finds that the grading layers in Nguyen '185 and Moon "serve the same function in the respective devices" therefore substitution would have yielded predictable results. *Id.*

The Appellant responds that "there is no disclosure of grading of aluminum in the captioned portion of *Moon*; and [Moon's] disclosure of intermediate transition layer is unclear." Reply Br. 9. Appellant also asserts that the Examiner has failed to provide an articulated reasoning with some rational underpinning to support the obviousness rejection of claim 8. *Id.*

The preponderance of the evidence supports the Examiner's finding that Nguyen '185 teaches a graded semiconductor layer between III-V semiconductor layers and that Moon teaches advantages for using an AlGaAsSb alloy layer where "the Al constituent of an epitaxial layer of AlGaAsSb is varied" and lattice grading of the layer is obtained. Moon 2:1–2. Therefore, Appellant has not persuaded us of a reversible error in the Examiner's rejection of claim 8 over Nguyen '185 and Moon.

CONCLUSION

We sustain the Examiner's rejections.

DECISION

For the reasons stated above, we affirm the Examiner's decision to reject claims 1–3 and 6–16. Because we recognize our decision is based in part on reasoning which differs from that advanced by the Examiner, we denominate the affirmed rejection of claims 1–3, 6, and 7 under 35 U.S.C. § 102(b) as a NEW GROUND OF REJECTION pursuant to 37 C.F.R. § 41.50(b).

TIME PERIOD FOR RESPONSE

This decision contains a new ground of rejection pursuant to 37 C.F.R. § 41.50(b). 37 C.F.R. § 41.50(b) provides "[a] new ground of rejection pursuant to this paragraph shall not be considered final for judicial review."

37 C.F.R. § 41.50(b) also provides that the Appellant, WITHIN TWO MONTHS FROM THE DATE OF THE DECISION, must exercise one of the following two options with respect to the new ground of rejection to avoid termination of the appeal as to the rejected claims:

> (1) Reopen prosecution. Submit an appropriate amendment of the claims so rejected or new evidence relating to the claims so rejected, or both, and have the matter reconsidered by the examiner, in which event the proceeding will be remanded to the examiner. . . .
>
> (2) Request rehearing. Request that the proceeding be reheard under § 41.52 by the Board upon the same record. . . .

No time period for taking any subsequent action in connection with this appeal may be extended under 37 C.F.R. § 1.136(a)(1)(iv).

AFFIRMED/NEW GROUND OF REJECTION (37 C.F.R. § 41.50(b))