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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

Ex parte THOMAS HERMAN

Appeal 2018-004797
Application 15/191,863[1]
Technology Center 2800

Before KAREN M. HASTINGS, JAMES C. HOUSEL, and JEFFREY R. SNAY, *Administrative Patent Judges*.

SNAY, *Administrative Patent Judge*.

DECISION ON APPEAL

Appellant filed an appeal under 35 U.S.C. § 134(a) from the Examiner's decision rejecting claims 44–47 and 49–67. We have jurisdiction under 35 U.S.C. § 6(b).[2]

We REVERSE.

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[1] Appellant is the Applicant, INFINEON TECHNOLOGIES AMERICAS CORP., which, according to the Appeal Brief, is the real party in interest. Appeal Brief (Appeal Br. 2) filed Dec. 18, 2017.

[2] Our Decision additionally refers to the Specification filed June 24, 2016 ("Spec."), the Final Office Action dated July 5, 2017 ("Final Act."), the Examiner's Answer dated Feb. 12, 2018 ("Ans."), and the Reply Brief dated Apr. 4, 2018 ("Reply Br.").

BACKGROUND

The subject matter on appeal relates to power semiconductor devices (*see*, *e.g.*, claim 44). The Inventor discloses that a high electric field build-up near the gate arrangement of conventional III-nitride power semiconductor devices results in gate breakdown and that such conventional devices also exhibit low drain-source breakdown voltage and time dependent degradation of device parameters due to hot carriers and charge trapping. Spec. ¶¶ 3, 7. In view of this, the Inventor discloses a device in which the mobile charge concentration is reduced in a region under the gate to keep a parasitic-source-drain series resistance at a low value. *Id.* ¶ 14. According to the Inventor, this is accomplished in one embodiment via a reduced charge region that is less conductive than adjacent regions of a two-dimensional electron gas (2DEG) of a device when the 2DEG is in a conductive state, which results in weaker electric fields near the edges of a gate arrangement above the reduced charge region in comparison to prior devices. *Id.* ¶ 28.

Independent claim 44 is illustrative and is reproduced below from the Claims Appendix of the Appeal Brief. Limitations at issue are italicized.

> 44. A power semiconductor device, comprising:
>
> a III-nitride heterojunction body that includes a first III-nitride body and a second III-nitride body having a different band gap than that of said first III-nitride body;
>
> a first power electrode comprising a conductive material coupled to said second III-nitride body;
>
> a second power electrode comprising said conductive material coupled to said second III-nitride body;
>
> a gate arrangement including a gate electrode disposed between said first and said second power electrodes;
>
> *a conductive channel that includes a two-dimensional electron gas (2DEG) that in a conductive state includes a*

reduced charge region produced by an implanted region in said second III-nitride body under said gate electrode, wherein said reduced charge region is less conductive than regions of said 2DEG adjacent each side of said reduced charge region;

said implanted region having implanted charge in said second III-nitride body, said implanted charge configured to repel electrons in said 2DEG under and beyond edges of said gate electrode;

said reduced charge region extending beyond at least one of said edges of said gate electrode and *comprising negative charge which repels negative carriers in a region below said gate arrangement, said conductive channel being devoid of said negative charge in said regions of said 2DEG adjacent each side of said reduced charge region.*

REJECTIONS ON APPEAL

I. claims 44, 47, 49–52, 56–61, and 64–67[3] under 35 U.S.C. § 102(b) as being anticipated by Kasahara;[4]

II. claims 45, 46, and 55 as being unpatentable under 35 U.S.C. § 103(a) over Kasahara in view of Kinzer;[5]

III. claims 53 and 54 as being unpatentable under 35 U.S.C. § 103(a) over Kasahara in view of Saxler;[6]

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[3] The Examiner includes claim 48 in the statement of the rejection (Final Act. 4) and sets forth a rejection for claim 48 (*id.* at 6) but claim 48 was canceled via an amendment filed May 4, 2017. Therefore, claims 44–47 and 49–67 are before us on appeal.

[4] Kasahara et al., US 2002/0017648 A1, published Feb. 14, 2002 ("Kasahara").

[5] Kinzer et al., US 2005/0189561 A1, published Sept. 1, 2005 ("Kinzer").

[6] Saxler et al., US 7,612,390 B2, issued Nov. 3, 2009 ("Saxler").

IV. claims 62 and 63 as being unpatentable under 35 U.S.C. § 103 over Kasahara in view of Parikh;[7] and

V. claims 44–47 and 49–67 on the ground of nonstatutory double patenting over claims 22, 24, 25, 31, 32, and 34–43 of U.S. Patent Application No. 12/162,749 in view of Kasahara.

DISCUSSION

Rejection I

Claims 44, 47, 49–52, 56–61, and 64–67 are rejected under 35 U.S.C. § 102(b) as being anticipated by Kasahara.

The Examiner finds Kasahara discloses a power semiconductor device comprising, among other things, a conductive channel including a reduced charge region that is less conductive, wherein the reduced charge region comprises a negative charge that repels negative carriers in a region below a gate arrangement and wherein the conductive region is devoid of the negative charge in regions of a 2DEG of the conductive channel adjacent each side of the reduced charge region, citing the n- region depicted in Kasahara's Figure 13 as a reduced charge region. Final Act. 4–6; Ans. 3–5.

Appellant contends Kasahara does not disclose a conductive channel including a reduced charge region so that the conductive channel is devoid of a negative charge in regions of the channel's 2DEG adjacent each side of the reduced charge region, as recited in claim 44, because Kasahara discloses n+ regions of the 2DEG having a higher negative charge (i.e.,

[7] Parikh et al., US 7,501,669 B2, issued Mar. 10, 2009 ("Parikh").

higher electron density) on each side of the n- region in Figure 13, where the 2DEG has a lower electron density. Appeal Br. 4, 8–9; Reply Br. 4.

Appellant's arguments are persuasive. Kasahara discloses a semiconductor device comprising an active layer, an electron supply layer, and a 2DEG produced at an interface between the layers. Kasahara ¶ 2. The device has a first area having a relatively low two-dimensional electron concentration (i.e., channel concentration) formed under a gate electrode and a second area having a relatively high two-dimensional electron concentration formed under a source electrode and under a gate electrode. *Id.* ¶¶ 8, 11. In one embodiment, Kasahara achieves the areas of different electron concentrations by providing different portions of an AlGaN material, which functions as an electron supply layer, with different aluminum contents. *Id.* ¶¶ 13–14, 17, 30, 33. Kasahara discloses that channel portions under high aluminum content areas have high electron concentrations and channel portions under low aluminum content areas have low electron concentrations. *Id.* ¶ 29.

According to another embodiment, the aluminum content for the AlGaN electron supply layer is varied with distance from the active layer, which produces a distribution of induced charge that provides two-dimensional electron concentrations. *Id.* ¶ 15. For instance, in the case of the embodiment depicted in Figure 13, Kasahara discloses the electron supply layer 10 is an AlGaN layer having an Al content that increases during formation. *Id.* ¶¶ 67–68. As explained by Kasahara in paragraph 24, such a configuration results in a two dimensional electron concentration. As noted above, Kasahara explains that such an arrangement results in a reduced

channel concentration (i.e., electron concentration) under the gate and an increased channel concentration for the source and drain areas. *Id.* ¶ 8, 11.

As argued by Appellant (Appeal Br. 7, 9), the arrangement of claim 44 can be achieved by introducing extraneous charges into the region of the conductive channel (e.g., via ion implantation), thus providing excess charge that repels negative carriers. *See* Spec. ¶ 31. As noted above, Kasahara's structure, such as the configuration depicted in Figure 13, results in a two-dimensional concentration arrangement in which a relatively low electron concentration area beneath the gate is between two areas of relatively high electron concentration, not an area under the gate of high charge relative to its neighboring regions.

In view of this, the Examiner has not sufficiently explained how Kasahara's structure anticipates a conductive channel that includes a reduced charge region that comprises a negative charge that repels negative carriers in a region below a gate arrangement, wherein the conductive channel is devoid of the negative charge in regions of a 2DEG adjacent each side of the reduced charge region, as recited in claim 44.

Claims 47, 49–52, 56–61, and 64–67 depend from claim 44. For these reasons, we do not sustain the Examiner's § 102 rejection of claims 44, 47–52, 56–61, and 64–67 over Kasahara.

Rejections II–IV

Claims 45, 46, and 55 are rejected as being unpatentable under 35 U.S.C. § 103(a) over Kasahara in view of Kinzer.

Claims 53 and 54 are rejected as being unpatentable under 35 U.S.C. § 103(a) over Kasahara in view of Saxler.

Claims 62 and 63 are rejected as being unpatentable under 35 U.S.C. § 103 over Kasahara in view of Parikh.

The Examiner does not rely on Kinzer, Saxler, or Parikh to remedy the deficiencies discussed above with regard to the § 102 rejection of claim 44 over Kasahara. Therefore, we do not sustain the § 103 rejections of claims 45, 46, 53–55, 62, and 63.

Rejection V

Claims 44–47 and 49–67 are rejected on the ground of nonstatutory double patenting over claims 22, 24, 25, 31, 32, and 34–43 of U.S. Patent Application No. 12/162,749 in view of Kasahara.

Appellant has not presented arguments for this rejection. U.S. Patent Application No. 12/162,749 issued as US 9,391,185 on July 12, 2016. In view of the issuance of US 9,391,185 and the unspecified reliance on Kasahara[8] in this rejection, we leave it to the Examiner to assess whether any obviousness type patenting rejection should be made based on the claims issued in US 9,391,185.

As a result, we do not reach the double patenting rejection of claims 44–47 and 49–67.

[8] Because the rejection consists of the statement "[a]though the claims at issue are not identical, they are not patentably distinct from each other" (Final Act. 3), the record is unclear as to what extent Kasahara is relied upon in the double patenting rejection.

DECISION

On the record before us and for the reasons given in Appellant's Appeal Brief and above, we *reverse* the Examiner's rejections under 35 U.S.C. §§ 102 and 103. We do not reach the Examiner's double patenting rejection over U.S. Patent Application No. 12/162,749.

REVERSED