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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/608,350	09/10/2012	Brett Adam Hull	5308-1078CT	3327

20792 7590 10/27/2016

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ART UNIT	PAPER NUMBER
2826	

MAIL DATE	DELIVERY MODE
10/27/2016	PAPER

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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

Ex parte BRETT ADAM HULL and
QINGCHUN ZHANG

Appeal 2015-004602
Application 13/608,350
Technology Center 2800

Before ADRIENE LEPIANE HANLON, CATHERINE Q. TIMM, and JAMES C. HOUSEL, *Administrative Patent Judges*.

PER CURIAM.

DECISION ON APPEAL[1]

STATEMENT OF THE CASE

Appellants[2] filed an appeal under 35 U.S.C. § 134 from the Examiner's decision finally rejecting claims 2, 3, 5–9, 11, 12, 14–17, 31, and

[1] Our decision refers to the Specification filed Sept. 10, 2012 (Spec.), the Final Office Action mailed Feb. 26, 2014 (Final Act.), Appellants' Appeal Brief filed July 10, 2014 (Appeal Br.), the Examiner's Answer mailed Jan. 14, 2015 (Ans.), and Appellants' Reply Brief filed Mar. 12, 2015 (Reply Br.).

[2] Appellants identify the real party in interest as Cree, Inc. Appeal Br. 1.

32[3] under 35 U.S.C. § 103(a) as being unpatentable over Mitsuhiro[4] in view of Kusumoto[5] and rejecting claims 4 and 13 under 35 U.S.C. § 103(a) as being unpatentable over Mitsuhiro and Kusumoto and further in view of Kumar.[6] We have jurisdiction under 35 U.S.C. §§ 6(b) and 134(a).

We AFFIRM.

The claims on appeal are directed to semiconductor devices (*see, e.g.*, claims 2, 5, 9, and 12). Appellants' Figure 4A is reproduced below.

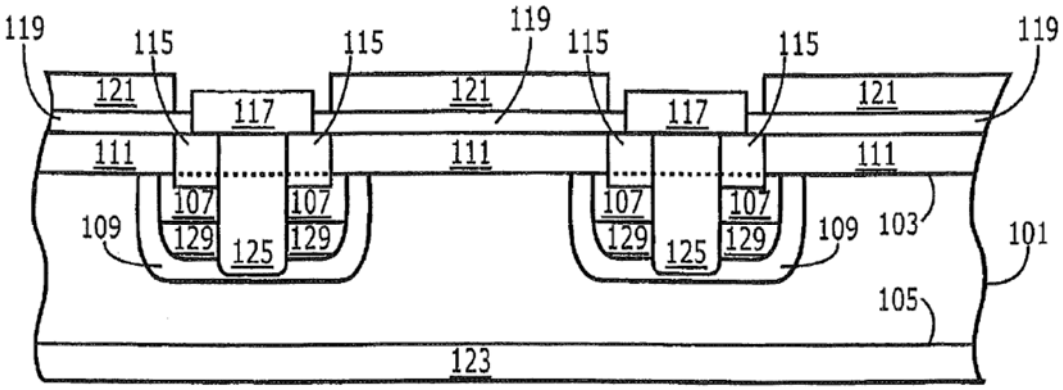

Figure 4A

Figure 4A is a cross-section of a semiconductor device.

Figure 4A depicts a double diffused metal oxide semiconductor field effect transistor (DMOSFET) including a semiconductor layer 101 having a first conductivity type (e.g., n-type conductivity), source/drain terminal

[3] Claims 35–38 have been indicated as including allowable subject matter and claims 18–30, 33, 34, and 39 have been allowed.
[4] Mitsuhiro et al., JP 2002-270837 A, published Sept. 20, 2002 ("Mitsuhiro"), as translated.
[5] Kusumoto et al., US 2005/0001217 A1, published Jan. 6, 2005 ("Kusumoto").
[6] Kumar et al., US 6,573,534 B1, issued June 3, 2003 ("Kumar").

regions 107 of the first conductivity type, and well regions 109 of a second conductivity type (e.g., p-type conductivity). Spec. p. 10, ll. 9–19. An epitaxial semiconductor layer 111 is provided on the surface 103 of the semiconductor layer 101, with the epitaxial semiconductor layer 111 including source/drain terminal contact regions 115 of the first conductivity type. Spec. p. 10, ll. 24–27. Ohmic contacts 117 are provided on the terminal contact regions 115 and a gate insulating layer 119 and gate electrode 121 are provided on the epitaxial semiconductor layer 111. Spec. p. 10, l. 30 to p. 11, l. 3. Well contact regions 125 of the second conductivity type may also be provided through the terminal contact regions 115 to provide electrical contact between ohmic contacts 117 and well regions 109. Spec. p. 11, ll. 8–11.

Appellants disclose controlling the gate electrode 121 so portions of well regions 109 adjacent surface 103 of the semiconductor layer 101 between terminal regions 107 and the outer perimeter of the well regions 109 define a channel so current may flow between ohmic contacts 117, 125 through terminal contact regions 115, terminal regions 107, channels of well regions 109, the epitaxial semiconductor layer 111, and the semiconductor layer 101. Spec. p. 11, ll. 24–29.

Independent claim 2 is illustrative of the subject matter on appeal. Claim 2 is reproduced from the Claims Appendix of the Appeal Brief with limitations at issue in the appeal italicized:

> 2. A semiconductor device comprising:
> a semiconductor layer having a first conductivity type;
> a well region of a second conductivity type in the semiconductor layer wherein the first and second conductivity types are different;

> a terminal region of the first conductivity type in the well region;
>
> an epitaxial semiconductor layer on a surface of the semiconductor layer including the well region and the terminal region wherein the epitaxial semiconductor layer has the first conductivity type on the terminal region and portions of the well region surrounding the terminal region at the surface of the semiconductor layer, and wherein the epitaxial semiconductor layer extends across an entirety of the well region and the terminal region at the surface of the semiconductor layer;
>
> a gate electrode on the epitaxial semiconductor layer so that the epitaxial semiconductor layer is between the gate electrode and portions of the well region surrounding the terminal region at the surface of the semiconductor layer; and
>
> an ohmic contact on the epitaxial semiconductor layer, *wherein the epitaxial semiconductor layer includes a terminal contact region of the first conductivity type therethrough providing electrical contact between the ohmic contact and the terminal region, and wherein the epitaxial semiconductor layer includes a well contact region of the second conductivity type therethrough providing electrical contact between the ohmic contact and the well region.*

Appeal Br. 12 (Claims App'x) (emphasis added).

OPINION

Obviousness Rejection over Mitsuhiro and Kusumoto

Claims 2, 3, 5–9, 11, 12, 14–17, 31, and 32 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Mitsuhiro in view of Kusumoto. Appellants do not substantively argue the claims separately. Appeal Br. 4–11. We select claim 2 as representative for discussing the issues on appeal.

The dispositive issue on appeal is whether Appellants have demonstrated the combination of Mitsuhiro and Kusumoto does not disclose or suggest an epitaxial semiconductor layer including "a well contact region

of the second conductivity type therethrough providing electrical contact between the ohmic contact and the well region," as recited in claim 2.

Figure 6(c) of Mitsuhiro is reproduced below.

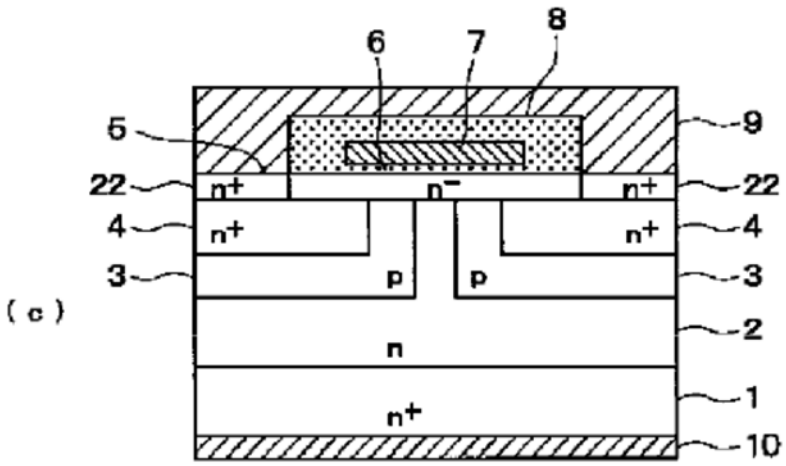

Figure 6(c) depicts a step in a manufacturing process for a MOSFET

Figure 6(c) is a cross-section of a semiconductor device including a drain electrode 10, an n^+-type board 1, an n^--type epilayer 2, a p-type base region 3, an n^+-type source region 4, a surface channel layer 5, a contact layer 22, a gate oxide 6, a gate electrode 7, and a source electrode 9. Mitsuhiro ¶¶ 31–35, 41, 43–45.

The Examiner finds the n^--type epilayer 2 functions as a semiconductor layer, the p-type base region 3 functions as a well region, and the n^+-type source region 4 serves as a terminal region. Final Act. 3. The Examiner further finds the surface channel layer 5 and contact layer 22 function as an epitaxial semiconductor layer that extends across an entirety of the well region (the p-type base region 3) and the terminal region (the n^+-type source region 4) at a surface of the semiconductor layer (the n^--type

epilayer 2). Final Act. 3–4. The Examiner finds the epitaxial semiconductor layer of Mitsuhiro includes a terminal contact region (i.e., contact layer 22) therethrough to provide electrical contact between an ohmic contact (source electrode 9) and the terminal region (the n^+-type source region 4). Final Act. 4.

The Examiner finds Mitsuhiro does not show the well contact portion of the device. Final Act. 4.

The Examiner finds Kusumoto discloses an epitaxial semiconductor layer and a well contact region, citing Figures 1 and 4B of Kusumoto. Figure 4B of Kusumoto is reproduced below.

FIG. 4B

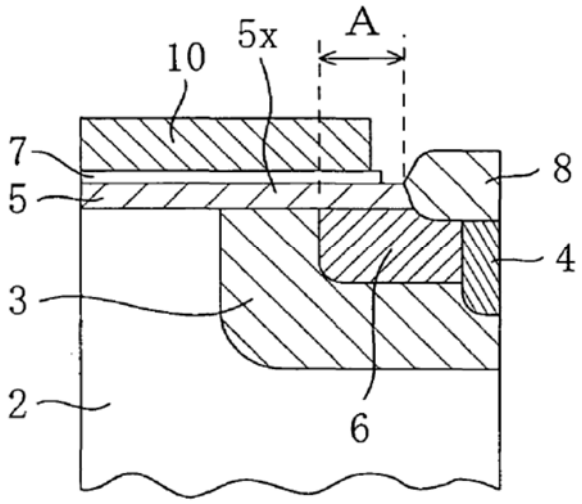

Figure 4B depicts a cross-sectional view of a semiconductor device

The semiconductor device includes a SiC layer 2, a p-well region 3, a p+ contact region 4, an epitaxially grown layer 5, a source region 6, a gate electrode 10, and a source electrode 8. Kusumoto ¶ 65. The Examiner finds the p+ contact region 4 serves as a well contact region that provides

electrical contact between the ohmic contact 8 and the p-well region 3. Final Act. 4–5. The Examiner concludes it would have been obvious to modify the device of Mitsuhiro in view of Kusumoto to make a functional semiconductor device. Final Act. 5.

Appellants argue Kusumoto does not disclose or suggest either the terminal contact region or the well contact region through the epitaxially grown layer, as required by claim 2. Appeal Br. 8. In particular, Appellants contend Kusumoto discloses a source electrode 8 that passes through the epitaxially grown layer 5 to reach the source region 6 and the p+ contact region 4. Appeal Br. 8; Reply Br. 2–4. Thus, the p+ contact region 4 of Kusumoto does not extend through the epitaxially grown layer 5 and the combination of Mitsuhiro and Kusumoto does not disclose or suggest the structure of claim 2. Appeal Br. 8–9.

Appellants' arguments are unpersuasive of reversible error. First, Appellants' argument that Kusumoto does not disclose a terminal contact region, as recited in claim 2, does not address the Examiner's rejection because the Examiner finds the epitaxial semiconductor layer of Mitsuhiro includes a terminal contact region (i.e., contact layer 22). Final Act. 4.

Second, Appellants' argument that Kusumoto discloses a well contact region that does not extend through an epitaxial layer does not properly address the Examiner's finding of a suggestion within the combination of Mitsuhiro and Kusumoto of extending a well contact region in a device having the epitaxial layers 5 and 22 of Mitsuhiro.

The Examiner explains Figure 6(a) of Mitsuhiro depicts a half p-well. Ans. 6. To construct a full p-well, one would place the structure of Figure 6(a) of Mitsuhiro side by side with the same structure. Ans. 7. The

Examiner further explains that, in order to modify Mitsuhiro in view of Kusumoto, a well contact region would necessarily pass through the epitaxial layer (i.e., layers 5 and 22 of Mitsuhiro) so an electrical contact is made between the source electrode, the source region, and the well contact region. Ans. 7.

As noted above, the Examiner finds the source electrode 9 of Mitsuhiro functions as an ohmic contact. Final Act. 4. Moreover, as shown in Figure 6(c) of Mitsuhiro above, the source electrode 9 of Mitsuhiro is located above the epitaxial layer 5. Therefore, in order for Mitsuhiro to be modified in view of Kusumoto to include a well contact region that provides an electrical contact between an ohmic contact (i.e., source electrode 9 of Mitsuhiro) and a well region (i.e., p-type base region 3 of Mitsuhiro), the well contact region must extend from the source electrode 9 of Mitsuhiro, which is located above the epitaxial layer 5, through the epitaxial layer 5 to the p-type base region 3 below. The Examiner further explains modifying Mitsuhiro to include a well contact region would prevent the p-well of Mitsuhiro from electrically floating and would permit the p-well to be electrically biased by a voltage supplied via the well contact region and the ohmic contact. Ans. 7.

In response to the Examiner's explanation, Appellants restate their argument that Mitsuhiro does not disclose a well contact region and Kusomoto discloses a source electrode 8 that extends through the epitaxially grown layer 5 to the p+ contact region 4 below. Reply Br. 4. Appellants contend the Examiner's explanation contradicts the disclosure of Kusumoto, which discloses a p+ contact region 4 not included in the epitaxially grown layer 5. Reply Br. 5.

Appellants' arguments focus upon what Kusumoto alone would have suggested to one of ordinary skill in the art by noting Kusomoto's disclosure of a source electrode 8 that extends through the epitaxially grown layer 5 to the p+ contact region 4. However, "the test for combining references is not what the individual references themselves suggest but rather what the combination of disclosures taken as a whole would suggest to one of ordinary skill in the art." *In re McLaughlin*, 443 F.2d 1392, 1395 (CCPA 1971). As explained by the Examiner, the combination of the disclosure of Mitsuhiro, which discloses an ohmic contact (i.e., source electrode 9) located above an epitaxial semiconductor layer (i.e., surface channel layer 5) and a well region (i.e., the p-type base region 3), and the disclosure of Kusumoto, which discloses a well contact region (i.e., p+ contact region 4), would have suggested to one of ordinary skill in the art a well contact region extending from the ohmic contact of Mitsuhiro through the epitaxial semiconductor layer below to the well region.

Therefore, Appellants' arguments do not demonstrate that the combination of Mitsuhiro and Kusumoto does not disclose or suggest an epitaxial semiconductor layer including "a well contact region of the second conductivity type therethrough providing electrical contact between the ohmic contact and the well region," as recited in claim 2.

Appellants further contend Kusumoto teaches away from forming a well contact region through an epitaxial semiconductor layer because Kusumoto teaches away from forming a source region 6 through the epitaxially grown layer 5. Appeal Br. 9; Reply Br. 5. This argument is also unpersuasive of reversible error. "A reference does not teach away . . . if it . . . does not 'criticize, discredit, or otherwise discourage' investigation into

the invention claimed." *DePuy Spine, Inc. v. Medtronic Sofamor Danek, Inc.*, 567 F.3d 1314, 1327 (Fed. Cir. 2009) (quoting *In re Fulton*, 391 F.3d 1195, 1201 (Fed. Cir. 2004)). Appellants have not directed us to a disclosure, whether by Mitsuhiro or Kusumoto, criticizing, discrediting, or otherwise discouraging a well contact region extending from an ohmic contact through an epitaxial semiconductor layer to a well region when the ohmic contact is located above the epitaxial semiconductor layer, as in the disclosure of Mitsuhiro.

Appellants do not argue claims 3, 5–9, 11, 12, 14–17, 31, and 32 separately from claim 2. Appeal Br. 10–11.

For the reasons discussed above and those set forth in the Examiner's Answer, we sustain the Examiner's § 103 rejection of claims 2, 3, 5–9, 11, 12, 14–17, 31, and 32 over Mitsuhiro in view of Kusumoto.

Obviousness Rejection over Mitsuhiro, Kusumoto, and Kumar

Claims 4 and 13 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Mitsuhiro and Kusumoto and further in view of Kumar. Appellants do not advance separate arguments directed to the Examiner's additional findings and conclusions based upon Kumar. Therefore, we sustain the Examiner's § 103(a) rejection of claims 4 and 13 over the combination of Mitsuhiro, Kusumoto, and Kumar.

DECISION

The decision of the Examiner rejecting claims 2–9, 11–17, 31, and 32 under 35 U.S.C. § 103(a) is affirmed.

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).

AFFIRMED