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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

Ex parte ANTON MAUDER, HELMUT STRACK, and WOLFGANG WERNER

Appeal 2015-006456
Application 12/843,181
Technology Center 2800

Before BRADLEY R. GARRIS, BRIAN D. RANGE, and JENNIFER R. GUPTA, *Administrative Patent Judges*.

RANGE, *Administrative Patent Judge*.

DECISION ON APPEAL

SUMMARY

Appellants[1] appeal under 35 U.S.C. § 134(a) from the Examiner's decision rejecting claims 1–3, 7–14, 26, and 27. We have jurisdiction. 35 U.S.C. § 6(b).

We AFFIRM.

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[1] According to the Appellants, the real party in interest is INFINEON TECHNOLOGIES AG. Appeal Br. 2.

STATEMENT OF THE CASE

Appellants describe the present invention as encompassing a particular structure of a field effect transistor (claims 1 and 13) or field effect power semiconductor device (claim 11). Appeal Br. 4. Claims 1, 11, and 13, reproduced below with emphases added to certain key recitations, are the three independent claims on appeal and are illustrative of the claimed subject matter:

> 1. A normally-off transistor, comprising a semiconductor body, comprising:
>
> a body region of a first conductivity type comprising a first doping concentration;
>
> a channel region of a second conductivity type forming a pn-junction with the body region;
>
> an insulated gate structure comprising a gate electrode and a static layer of trapped charges arranged between the gate electrode and the channel region, the gate electrode being insulated against the channel region; and
>
> wherein a charge carrier type of the trapped charges is the same as a charge carrier type of majority charge carriers of the channel region, and a charge carrier density per area of the trapped charges is equal to or larger than a doping concentration per area of the channel region, **wherein the doping concentration per area of the channel region is an average of the doping concentration between the body region and the insulated gate structure** multiplied with a distance between the body region and the insulated gate structure.

> 11. A power semiconductor device, comprising:
>
> a semiconductor body, comprising:
>
> a main horizontal surface;

a first semiconductor region of a second conductivity type comprising a first doping concentration and extending to the main horizontal surface; and

a second semiconductor region of a first conductivity type forming a pn-junction with the first semiconductor region;

the power semiconductor device further comprising:

a gate structure arranged on the main horizontal surface and separated from the second semiconductor region by the first semiconductor region, comprising a gate electrode and **being configured to comprise static trapped charges such that a space charge region is formed which extends from the main horizontal surface at least to the second semiconductor region when the gate electrode is on the same potential as the first semiconductor region and the second semiconductor region.**

13. A normally-off field-effect transistor semiconductor device, comprising:

a **source electrode arranged on a main surface**;

a **drain electrode arranged on a back surface that is spaced apart from and opposite to the main surface**;

a **channel region operable to carry an electron current between the source electrode and the drain electrode**;

a gate electrode; and

trapped negative charges;

wherein the gate electrode is insulated against the trapped negative charges and the channel region, and the trapped negative charges are arranged statically between the gate electrode and the channel region such that the channel region is in an off-state when the

source electrode and the gate electrode are on the same electric potential.

Appeal Br.[2] 30–33 (Claims App'x).

REFERENCES

The Examiner relies upon the prior art below in rejecting the claims on appeal:

Williams	US 5,156,989	Oct. 20, 1992
Blanchard	US 2008/0023763 A1	Jan. 31, 2008
Kimoto	US 2009/0173973 A1	July 9, 2009
Dhar	US 2011/0049530 A1	Mar. 3, 2011

REJECTIONS

The Examiner maintains the following rejections on appeal:

Rejection 1. Claims 13 and 14 under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the applicant regards as the invention. Ans. 2.

Rejection 2. Claim 13 under 35 U.S.C. § 102(e) as anticipated by Dhar. *Id.* 3.

Rejection 3. Claim 14 under 35 U.S.C. § 103 as unpatentable over Dhar. *Id.* at 4.

Rejection 4. Claims 1–3, 7–14, 26, and 27 under 35 U.S.C. § 103 as unpatentable over Dhar and Kimoto in view of Williams and Blanchard, or

[2] In this decision, we refer to the Final Office Action mailed June 19, 2014 ("Final Act."), the Appeal Brief filed February 23, 2015 ("Appeal Br."), the Examiner's Answer mailed April 20, 2015 ("Ans."), and the Reply Brief filed June 22, 2015 ("Reply Br.").

alternatively, over Williams and Blanchard in view of Dhar and Kimoto. *Id.* at 4.

ANALYSIS

We review the appealed rejections for error based upon the issues identified by Appellants in the record and in light of the arguments and evidence produced therein. *Cf. Ex parte Frye*, 94 USPQ2d 1072, 1075 (BPAI 2010) (precedential) (cited with approval in *In re Jung*, 637 F.3d 1356, 1365 (Fed. Cir. 2011) ("it has long been the Board's practice to require an applicant to identify the alleged error in the examiner's rejections")).

After having considered the evidence presented in this Appeal and each of Appellants' contentions, we are not persuaded that Appellants identify reversible error except as explained below, and we affirm the Examiner's second, third, and fourth rejections for the reasons expressed in the Final Office Action and the Answer. We add the discussion below primarily for emphasis.

Rejection 1. The Examiner rejects claims 13 and 14 as indefinite under 35 U.S.C. § 112, second paragraph. The Examiner maintains "a main surface" and "a back surface" as recited in claim 13 are indefinite because it is not clear as to which element(s) the surfaces refer. Ans. 2. Appellants, however, explain that "a main surface" and "a back surface" are not ambiguous in view of the Specification. Appeal Br. 23. In particular, Figure 1 of the Specification and the related text indicates that main surface 15 and back surface 16 are surfaces of a semiconductor device with "back surface 16 arranged opposite to the first surface 15." Spec. Fig. 1, ¶ 25. Claim 13 recites "[a] normally-off field-effect transistor semiconductor device," and, given the context provided by the Specification, a person of skill in the art

would understand the recited "a main surface" and "a back surface" as being surfaces of the recited semiconductor device with the back surface arranged opposite the first surface. Accordingly, we do not sustain the Examiner's rejection of claims 13 and 14 under 35 U.S.C. § 112, second paragraph.

Rejection 2. The Examiner rejects claim 13 as 35 U.S.C. § 102(e) as anticipated by Dhar. Ans. 3. The Examiner finds that Dhar teaches each element of claim 13. Ans. 2–3 (providing citations to Dhar). The Examiner references Figure 3 of Dhar, reproduced below:

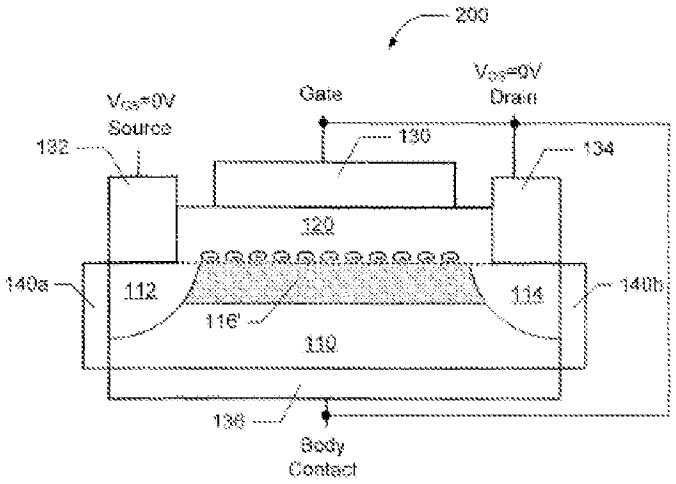

FIGURE 3

Figure 3 of Dhar depicts a cross-sectional view of a MISFET (metal-insulator-semiconductor field-effect transistor) when zero voltage is present between a gate contact and a source region in accordance with some embodiments of Dhar's invention.

The Examiner finds that elements 134 and 136 can be considered the drain electrode because they are electrically connected by a short circuit in Figure 3. Ans. 3. A portion of this drain electrode, in particular element 136, is located on the back surface of the element 110. *Id.* at 3, 31. A preponderance of the evidence supports these findings.

Appellants argue that body contact 136 cannot correspond to a drain electrode because "body contacts . . . maintain the body of the device at a reference potential." Appeal Br. 21. Appellants, however, fail to persuasively rebut that, in Figure 3, elements 134 and 136 are electrically connected to form, electrically, a single drain element.

Appellants also argue that Dhar's device lacks "a channel region operable to carry an electron current between the source electrode and the drain electrode" as recited by claim 13. Appeal Br. 21. Figure 3 of Dhar, however, depicts a channel region extending from source 132 to element 134, and element 134 is a portion of the drain in this configuration. Ans. 31.

Appellants have thus not identified reversible error as to the Examiner's rejection of claim 13 as anticipated by Dhar, and we sustain this rejection.

Rejection 3, claim 14. The Examiner rejects claim 14 as under 35 U.S.C. § 103 as unpatentable over Dhar. Ans. 4. Claim 14 depends from claim 13. Aside from providing the arguments concerning claim 13 addressed above, Appellants identify no error concerning this rejection. Thus, we sustain this rejection.

Rejection 4, summary. The Examiner rejects all claims on appeal (claims 1–3, 7–14, 26, and 27) under 35 U.S.C. § 103 as unpatentable over Dhar and Kimoto in view of Williams and Blanchard, or alternatively,[3] over

[3] The Examiner takes the position that Appellants did not address this alternative rejection and this rejection should thus be sustained. Ans. 40. The Examiner, however, did not fully articulate the difference between the two alternative obviousness theories, and Appellants addressed the combination of references adequately. Reply Br. 9–10. We therefore

Williams and Blanchard in view of Dhar and Kimoto. Ans. 4. Appellants argue independent claims 1 and 11 separately and argue dependent claims 26 and 27 separately. We first address claim 1 and claims depending from claim 1.

Rejection 4, claims 1–3, 7–10. Appellants do not separately argue claims 2, 3, or 7–10. We therefore focus on claim 1, and claims 2, 3, and 7–10 stand or fall with that claim. 37 C.F.R. § 41.37(c)(1)(iv) (2013).

The Examiner finds that Dhar and Kimoto teach much of the structure recited by claim 1. Ans. 5–6 (providing numerous citations to Dhar and Kimoto). The Examiner concludes that it would have been obvious to operate the Dhar/Kimoto device "such that the charge carrier type of the trapped charges is the same . . . and a charge carrier density . . . is equal to or larger than a doping concentration per area of the channel region, wherein the doping concentration per area of the channel region is an average of the doping concentration between the body region and the insulated gate structure multiplied with a distance between the body region and the insulated gate structure . . . ." Ans. 7. As further explained below, the preponderance of the evidence supports the Examiner's findings and conclusion.

We begin our analysis of claim 1 with claim construction. The Examiner erroneously concludes that claim 1's language "the doping concentration per area of the channel region is an average of the doping concentration between the body region and the insulated gate . . ." is non-limiting because claim 1's definition of "doping concentration per area of

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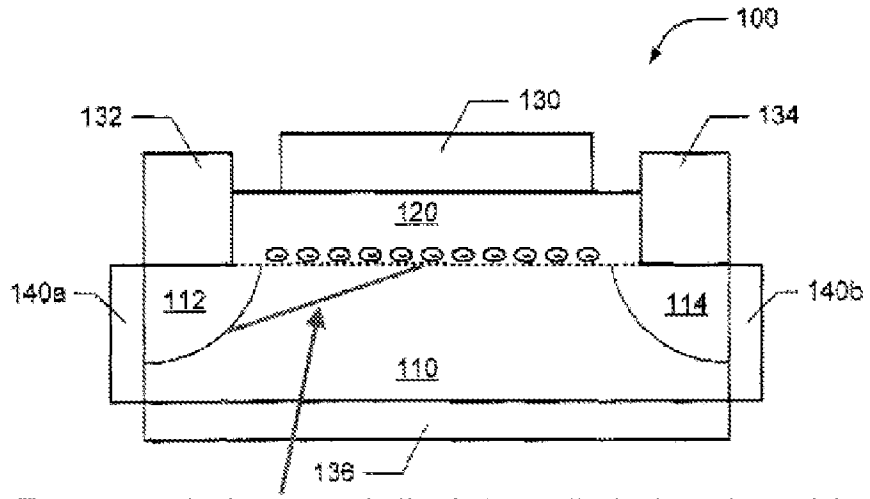
consider the Examiner's rejections on the merits while focusing on Dhar and Kimoto as primary references but while also keeping in mind the alternative.

the channel region" is a conventional parameter known in the art that claim 1 cannot redefine. Ans. 16. It is fundamental to patent law that "[a]ll words in a claim must be considered in judging the patentability of that claim against the prior art." *In re Wilson*, 424 F.2d 1382, 1385 (CCPA 1970); *see also* Reply Br. 2. Here, the recitations of claim 1 cannot be met unless there is some area with a "doping concentration between the body region and the insulated gate." For the reasons further explained below, however, the Examiner's error is ultimately harmless.

The Examiner also construes claim 1's recited "an average of the doping concentration between the body region and the insulated gate structure" as referring "to an average of the doping concentration which is located between any part of the body region and any part of the insulated gate structure." Ans. 17 (bolding removed). Ordinary dictionaries define "between" in this context as, for example, "in the time, space, or interval that separates." Merriam-Webster's Collegiate Dictionary 116 (Merriam-Webster, Inc., 11th ed. 2007); *see also* Reply Br. 3 (providing definition of between as "'in the space that separates (two things)'"). Consistent with the Specification and the plain and ordinary meaning of "between," we agree with Appellants that "a reasonable interpretation of the word 'between' does not allow for an interpretation in which two arbitrary locations [within the interior of] the body region and the insulated gate structure are selected to determine the 'average of the doping concentration.'" Reply Br. 3. In other words, "the distance between" two three-dimensional objects in this context cannot be the distance from an arbitrary point in the interior of one of the objects to an arbitrary point in the interior of the other object. Thus, for claim 1, the "average of the doping concentration between the body region

and the insulated gate structure" must be based upon structure "between" that separates a point on the surface of the body region and a point on the surface of the insulated gate structure such that the structure "between" does not include any portion of the body region or insulated gate structure.

The evidence supports Appellants' position that, with respect to the Kimoto and Dhar references, the body region and gate structures directly adjoin. *See, e.g.*, Appeal Br. 10. Given the claim construction above, however, this does not mean that there is zero distance between the body region and gate structures at every point. For example, the Examiner's annotated Figure 1 of Dhar (Ans. 19), reproduced below, illustrates a distance between the body region and the gate region:



Dhar's Figure 1 is a cross-sectional view of a MISFIT in accordance with some embodiments of Dhar. In the annotated figure above, the Examiner has drawn a line from body region 112 and gate structure 120 demonstrating a distance between those two structures. As illustrated by the annotated Dhar Figure 1 above, a portion of region 110 separates portions of

region 112 and structure 120 and is thus "between" certain points of region 112 and structure 120.

Figure 2 of Dhar is similar to Figure 1 "except for the addition of a doped channel region 116 that extends between the source region 112 and the drain region 114." Dhar ¶ 30 (emphasis omitted). The evidence supports the Examiner's finding that Dhar explicitly teaches that, for the Figure 2 embodiment, the charge carrier density of the trapped charges is equal to or larger than a doping concentration per area of the channel region. Ans. 26–27. In particular, Dhar states that the "net negative charge per unit area [of gate insulation layer 120] may be regulated through the manufacturing processes to provide a value that is at least as high as a net charge generated by dopants in an adjacent unit area of the doped channel region 116." Dhar ¶ 33 (emphasis omitted). Appellants do not persuasively rebut the Examiner's finding of fact in this regard.

Appellants also argue that the Examiner incorrectly correlates Dhar's source region 112 with the body region of the claims. Appeal Br. 13, n. 2. Appellants state that the correlation "disregards the plain meaning of the term 'source' and 'body' as understood by a person having ordinary skill in the art." *Id.* Appellants, however, present no evidence supporting how a person of ordinary skill would understand these terms. *See Teva Pharm. USA, Inc. v. Sandoz, Inc.*, 135 S. Ct. 831, 837–38 (2015) (recognizing that where claim includes "technical words or phrases not commonly understood" the words may give rise to a factual dispute); *Estee Lauder Inc. v. L'Oreal, S.A.*, 129 F.3d 588, 595 (Fed. Cir. 1997) ("arguments of counsel cannot take the place of evidence lacking in the record.") (internal quotes and citation omitted). Figure 1 of the Specification, meanwhile, indicates

that semiconductor body 40 encompasses a broad portion of the semiconductor device. Spec. Fig. 1; ¶ 25. It appears from Figure 1 that semiconductor body includes, for example, n+-type source region 4. *Id.* at ¶ 27. Thus, a preponderance of the evidence in the record supports that a source region may be part of a body region, and we thus conclude that the recited "body region" of claim 1 may be a source region. Therefore, under a broadest reasonable construction, we do not agree that the Examiner has erred by correlating Dhar's region 112 with claim 1's recited body region.

Because Appellants identify no reversible error with regard to the Examiner's findings and conclusions explained above, we sustain the Examiner's rejection of claims 1–3 and 7–10.

Rejection 4, claim 27. We next focus on claim 27 because it depends from claim 1. Claim 27 recites "The power semiconductor device of claim 1, wherein the device is configured as a vertical transistor so as to conduct current perpendicular to a main surface of the semiconductor body." Appeal Br. 36 (Claims App'x).

Appellants argue that Dhar, Kimoto, and Williams all disclose lateral devices that lack the recited elements of claim 27. Appeal Br. 26–29. The Examiner finds, however, that Dhar Figure 3 teaches that drain electrode 134 directly contacts body contact 136 so that current flows perpendicular to the main surface of the semiconductor body. Ans. 39. Appellants do not persuasively dispute this finding of fact. Appellants therefore fail to identify reversible error, and we sustain the Examiner's rejection of claim 27.

Rejection 4, claims 11 and 12. Appellants do not separately argue claim 12. We therefore focus on claim 11, and claim 12 stands or falls with that claim. 37 C.F.R. § 41.37(c)(1)(iv) (2013).

We begin our analysis of claim 11 with claim construction. Claim 11 recites "a gate structure . . . being configured to comprise static trapped charges such that a space charge region is formed which extends from the main horizontal surface at least to the second semiconductor region when the gate electrode is on the same potential as the first semiconductor region and the second conductor region." Appeal Br. 32 (Claims App'x). Claim 11 indicates that the space charge region changes size depending upon at least the potential of the gate electrode as compared to the first and second semiconductor regions. Thus, this language defines the device's function rather than its structure.

Although a patent applicant may recite features structurally or functionally, "choosing to define an element functionally, *i.e.*, by what it does, carries with it a risk." *In re Schreiber*, 128 F.3d 1473, 1478 (Fed. Cir. 1997). In particular, where there is reason to believe that prior art structure is capable of performing the claimed function, the burden shifts to the applicant to show that the claimed function patentably distinguishes the claimed structure from the prior art structure. *See id.*; *In re Hallman*, 655 F.2d 212, 215 (CCPA 1981) (affirming rejections where applicant failed to show that prior art structures were not capable of functioning as claimed invention). Moreover, "discovery of a previously unappreciated property of a prior art composition, or of a scientific explanation for the prior art's functioning, does not render the old composition patentably new to the discoverer." *See Atlas Powder Co. v. Ireco Inc.,* 190 F.3d 1342, 1347 (Fed. Cir. 1999) (citation omitted).

Appellants argue that "[c]laim 11 requires a relationship between the amount of trapped charges and the size of the depletion region extending

between the gate structure and the body region" and that this relationship has "no corresponding meaning in the context of Dhar and Kimoto." Appeal Br. 10. Appellants elaborate by arguing that "[t]he amount of trapped charges to induce a space charge region that extends **from** the alleged corresponding main horizontal surface … **to** the second semiconductor region in the devices of Dhar and Kimoto is **zero**, as the alleged corresponding second semiconductor regions directly adjoin the main horizontal surface in the devices of Dhar and Kimoto." Appeal Br. 17.

Appellants' argument is not persuasive for reasons similar to those explained with regard to claim 1. Claim 11 recites a space charge region may be formed "which extends from the main horizontal surface at least to the second semiconductor region." Appeal Br. 32 (Claims App'x). The Examiner finds that Dhar's element 112 (n+ source region 112, Dhar ¶ 26) corresponds to claim 11's recited second semiconductor region, and Dhar teaches a space charge region 116 (doped channel region 116, Dhar ¶ 30) extending from the main horizontal surface at least to the second semiconductor region 112. Ans. 28; *see also* Ans. 25, Dhar Fig. 2, ¶¶ 36, 50. In other words, although a portion of region 116 adjoins the main horizontal surface, the Examiner's finding is again based on a diagonal line extending from a lower portion of region 116 to a more central portion of the main horizontal surface. Ans. 19. As applied to Dhar Figure 2, the diagonal line would extend directly through channel region 116.

The Examiner finds that the channel region is capable of forming a space charge region. Ans. 25, 28. In particular, Dhar states,

> For p-type MISFETs, the gate insulation layer can be configured to provide a fixed positive charge along a surface facing a channel region that **depletes charge carriers** (e.g., holes) from at least an

> adjacent portion of the channel region [i.e., channel region 116 in Figure 2] when a zero voltage potential is present between the gate contact 130 and the source region 112 [i.e., when the gate electrode is on the same potential as the first and second semiconductor regions].

Dhar ¶ 36 (emphasis and bracketed material added). The phenomena Dhar describes is consistent with the construction of "space charge region" proposed by Appellants. Reply Br. 7. The Examiner has thus identified a structure meeting claim 11's structural recitations, and the Examiner provides adequate reason to believe the structure is capable of forming a space charge region as recited in claim 11. Appellants do not persuasively identify a patentable distinction in structure and therefore do not identify Examiner error. *Schreiber*, 128 F.3d at 1478. We thus sustain the Examiner's rejection of claims 11 and 12.

Rejection 4, claim 26. We next focus on claim 26 because it depends from claim 11. Claim 26 recites "[t]he power semiconductor device of claim 11, wherein the gate structure further comprises a gate dielectric layer that adjoins the first semiconductor region and is spaced apart from the p-n junction." Appellants persuasively argue that a p-n junction, as recited in claim 26, is a boundary or interface between regions. Reply Br. 8–9. Thus, the Examiner's position that Figure 1 of Dhar illustrates one p-njunction (i.e., one junction point in space) adjoining the gate dielectric although "[a]ll the other p-n junctions" (i.e., different points of the same p-n boundary/interface) are spaced apart from the gate dielectric as required by claim 26 (Ans. 37) cannot be sustained. Appeal Br. 24.

The Examiner, however, also provides an alternative theory based on Williams. The Examiner concludes that it would have been obvious to

combine the wrap-around n+ isolation region of Williams with Dhar "in order to improve the electrical isolation" and that using such an isolation region "is well known in the art . . . in order to improve the electrical performance of the devices." Ans. 21. Appellants do not persuasively rebut the underlying findings of fact supporting the Examiner's conclusion.

The Examiner further finds that if Williams were combined with Dhar, Williams' wrap-around n+ isolation region would form "a p-n junction with the p material of Dhar such that the gate dielectric layer is spaced apart from all the p-n junctions between the p material and the n material. Ans. 37. Appellants do not persuasively dispute this finding. Appellants also do not persuasively rebut the Examiner's explanation of why the combination of Dhar and Williams teaches the space charge region recited by claim 11. Ans. 28–29; *see also* Appeal Br. 17 (stating that "[o]ne would not seek to create a space charge region" as recited in claim 11 when combining Dhar and Williams but failing to provide reasons why a person of skill would not have done so).

Because Appellants do not identify reversible Examiner error, we sustain the Examiner's rejection of claim 26.

Ground 4, claims 13 and 14. The Examiner correctly states that Appellants did not provide argument concerning the Examiner's rejection of claims 13 and 14 as obvious over Dhar and Kimoto in view of Williams and Blanchard, or alternatively, over Williams and Blanchard in view of Dhar and Kimoto. Ans. 13. Rather, Appellants arguments concerning this combination of references relates to claims 1 and 11. *See, e.g.*, Appeal Br. 12 (providing heading entitled "§ 103 Rejections to Claims 1 and 11" (emphasis omitted)). Appellants arguments concerning claim 13 (and, in

turn, claim 14 which depends from claim 13) address only the anticipation and indefiniteness rejections. Appeal Br. 20, 22; *see also* Appeal Br. 9–12 (providing summary of argument that does not address the four reference obviousness rejection as applied to claim 13). We therefore sustain this rejection of claims 13 and 14.

DECISION

For the above reasons, we reverse (1) the Examiner's rejection of claims 13 and 14 under 35 U.S.C. § 112, second paragraph. We affirm the Examiner's (2) rejection of claim 13 under 35 U.S.C. § 102(e) as anticipated by Dhar, (3) rejection of claim 14 under 35 U.S.C. § 103 as unpatentable over Dhar, and (4) rejection of claims 1–3, 7–14, 26, and 27 under 35 U.S.C. § 103 as unpatentable over Dhar and Kimoto in view of Williams and Blanchard, or alternatively, over Williams and Blanchard in view of Dhar and Kimoto.

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

AFFIRMED