UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Ex parte RICHARD FRANCIS and CHIU NG

Appeal 2008-5587
Application 11/204,074[1]
Technology Center 2800

Decided: November 17, 2008

Before KENNETH W. HAIRSTON, SCOTT R. BOALICK,
and CARLA M. KRIVAK, *Administrative Patent Judges*.

HAIRSTON, *Administrative Patent Judge*.

DECISION ON APPEAL

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[1] Application filed August 15, 2005. The real party in interest is International Rectifier Corporation.

STATEMENT OF THE CASE

Appellants seek our review under 35 U.S.C. § 134 of the Examiner's final rejection of claims 1 to 14. We have jurisdiction under 35 U.S.C. § 6(b).

We sustain the Examiner's rejection.

The Invention

Appellants' claimed invention is directed to a trench type Insulated Gate Bipolar Transistor (IGBT) having a reduced forward voltage drop (Spec. 0002-0009; Fig. 2) which is accomplished by using a "deep diffusion layer" or "deep enhancement region 100" (Spec. 0029; Fig. 2). The emitter diffusion layer is arsenic-doped, and the deep diffusion layer is phosphorous-doped (Spec. 0031, 0032, 0034).

Representative Claim

Claim 1, reproduced below (with paragraphing added), is representative of the subject matter on appeal:

1. A trench IGBT having a deep diffusion for reducing its forward voltage drop, comprising

a body of monocrystaline silicon that includes at least one region of one of the conductivity types and a first concentration, and having a parallel top and bottom surfaces;

a plurality of spaced trenches extending perpendicularly into said top surface for a given depth;

a gate insulation layer lining the vertical walls of said trenches;

a channel diffusion of the other conductivity type formed between each of said trenches and having a depth which is less than the depth of said trenches;

an arsenic-doped emitter diffusion of said one of the conductivity types extending from said top surface of said body and along an upper portion of each of said trenches;

said emitter diffusions being spaced from one another by a given distance between said trenches;

a shallow contact diffusion of said other conductivity type which has a high concentration compared to that of said channel diffusion and disposed between adjacent pairs of said emitter diffusions;

a collector diffusion of said other conductivity type in said bottom surface;

an emitter metal electrode in contact with said emitter and channel diffusions and a collector electrode in contact with said collector diffusion; and

a phosphorous-doped deep diffusion of said one conductivity type and having a conductivity greater than that of said first conductivity disposed beneath said channel diffusion and extending to beneath the bottom of said trenches.[2]

The Prior Art

The Examiner relies upon the following as evidence of unpatentability:

Francis	US 6,683,331 B2	Jan. 27, 2004
Matsudai	US 6,683,343 B2	Jan. 27, 2004
Takahashi	US 6,768,168 B1	Jul. 27, 2004

[2] We note that in the last clause of claim 1, beginning "a phosphorous-doped …," the term "said first conductivity" lacks proper antecedent basis and it is not clear whether this term refers to "said one of the conductivity types" or "said other conductivity type." However, this issue was not disputed by the parties and it does not effect our decision herein.

The Rejection

The following rejection is before us for review:

The Examiner rejected claims 1 to 14 under 35 U.S.C. § 103(a) as being unpatentable over Takahashi, Francis, and Matsudai.

FINDINGS OF FACT

The relevant facts include the following:

1. As indicated *supra*, Appellants describe and claim a trench IGBT having a deep diffusion for reducing its forward voltage drop including a channel or base diffusion, an arsenic-doped emitter diffusion, and a phosphorous-doped deep diffusion beneath the channel or base diffusion (Spec. 0001, 0028, 0029, 0031, 0032, 0034; Fig. 2).
2. Appellants recognize that a common problem in the art with IGBT structures is their high on-resistance caused by the inherent JFET created by implementing IGBT's with a planar cellular or stripe technology (Spec. 0002). Appellants also recognize that it is known in the art that a high on-resistance causes a high drift region and spreading resistance below the channel or base region (Spec. 0007).
3. Appellants admit that Francis is known in the prior art and incorporate the disclosure of Francis by reference (Spec. 0005). Appellants describe various aspects of the prior art IGBT structure of Francis (Spec. 0005-0008, 0010, 0020-0027; Fig. 1), including using a "deep enhancement region 100" or "very deep emitter regions 40" to keep the turn-on resistance low (Spec. 0023 and 0026). Appellants admit that Francis provides "a deep emitter

diffusion" or "very deep P channel diffusion" between the trenches, which reduces resistance (Spec. 0005). Appellants also admit that Francis discloses "that arsenic may be used to form an emitter region" (Br. 6).

4. Appellants recognize that "[i]t would be very desirable to provide a device with the advantages of the device of patent 6,683,331 [Francis], but with a reduced on-resistance." (Spec. 0008).

5. Takahashi discloses a trench IGBT having a deep diffusion for reducing its forward voltage drop including a channel or base diffusion 44, an emitter diffusion 45, and a deep diffusion 43 (Fig. 16) (*see also* Ans. 3-4 and 9). Francis discloses a shallow contact diffusion 50 region and an arsenic-doped emitter region 80/81 (Figs. 1 and 5; col. 3, ll. 50-56) (*see also* Ans. 4-5, 9). Matsudai discloses an n-type phosphorous-doped layer 23 (Figs. 1 and 15A; col. 9, ll. 15-21) (*see also* Ans. 5 and 10).

THE ISSUE

Appellants assert that the Examiner erred in rejecting claims 1 to 14 under 35 U.S.C. § 103(a) as being obvious over Takahashi, Francis, and Matsudai (Br. 4-7). The Examiner replies that Appellants are incorrect, and that one of ordinary skill in the art would have been properly motivated to combine the teachings of Takahashi, Francis, and Matsudai as applied in the Answer (Ans. 8-10).

Claim 1 is the only independent claim. Appellants have not separately argued the merits of claims 2 to 14 (Br. 4-7), and instead present arguments drawn to Takahashi, Francis, and Matsudai with respect to the patentability of only claim 1 (*see* Br. 5-7). We consider claim 1 as being representative of the group

consisting of claims 1 to 14. Therefore, claims 2 to 14 stand or fall with representative claim 1. *See* 37 C.F.R. § 41.37(c)(1)(vii).

Thus, the issue becomes: Did the Examiner err in determining that the combination of Takahashi, Francis, and Matsudai teaches or suggests the subject matter of Appellants' claim 1?

PRINCIPLES OF LAW

"Section 103 forbids issuance of a patent when 'the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains.'" *KSR Int'l Co. v. Teleflex Inc*., 127 S. Ct. 1727, 1734 (2007). When "[an application] claims a structure already known in the prior art that is altered by the mere substitution of one element for another known in the field, the combination must do more than yield a predictable result." *KSR*, 127 S. Ct. at 1740 (internal citations omitted).

> The teaching, motivation, or suggestion may be implicit from the prior art as a whole, rather than expressly stated in the references," and "[t]he test for an implicit showing is what the combined teachings, knowledge of one of ordinary skill in the art, and the nature of the problem to be solved as a whole would have suggested to those of ordinary skill in the art.

In re Kahn, 441 F.3d 977, 987-88 (Fed. Cir. 2006).

The Examiner bears the initial burden of presenting a prima facie case of obviousness, and Appellants have the burden of presenting a rebuttal to the prima facie case. *In re Oetiker*, 977 F.2d 1443, 1445 (Fed. Cir. 1992).

ANALYSIS

Did the Examiner err in determining that Takahashi, Francis, and Matsudai teach or suggest the subject matter of Appellants' claim 1?

What the Applied References Disclose

We agree with the Examiner's findings of fact with regard to Takahashi, Francis, and Matsudai in relation to the limitations of claim 1 on appeal (Ans. 3-5 and 9-10) (Finding of Fact 5). In particular, we find as provided above that Takahashi discloses a trench IGBT having a deep diffusion for reducing its forward voltage drop including a deep diffusion region 43 (Fig. 16) (*see* Ans. 3-4 and 9); Francis discloses a shallow contact diffusion 50 and an arsenic-doped emitter region 80/81 (Fig. 5; col. 3, ll. 50-56) (*see* Ans. 4-5, 9); and Matsudai discloses a phosphorous-doped layer 23 (Figs. 1 and 15A; col. 9, ll. 15-21) (*see* Ans. 5 and 10). (Finding of Fact 5). We note that Appellants state in their Appeal Brief that, "the present invention shares some features of the device described in Francis" (Br. 6), and Appellants admit that Francis teaches a deep diffusion region and teaches using arsenic as a dopant in an emitter diffusion region (Finding of Fact 3). Finally, we agree with the Examiner that "the prior art of Francis and Matsudai … show the emitter region / deep diffusion regions are commonly composed of arsenic / phosphorous dopant atoms, respectively" (Ans. 9) and therefore supply the missing teachings of Takahashi (*see* Finding of Fact 5).

Motivation to Combine the References

We agree with the Examiner's reasoning supporting the obviousness of combining the teachings of Takahashi, Francis, and Matsudai (Ans. 9-10). We find all three of the applied references concern the same field of trench type IGBTs, and therefore, in accordance with *KSR*, one of ordinary skill in the art would have been motivated to look to the teachings of Francis and/or Matsudai as a way to overcome the known problems in the IGBT art of high on-resistance caused by the inherent JFET created by implementing IGBT's with a planar cellular or stripe technology (Spec. 0002), which are known to cause a high drift region and spreading resistance below the channel or base region (Spec. 0007) (Finding of Fact 2).

With respect to Francis, we agree with the Examiner that it would have been obvious to incorporate Francis' heavily P doped shallow contact regions 50 into Takahashi's IGBT "in order to promote a low resistance contact" as suggested by Francis (Francis at col. 4, ll. 34-40) (Ans. 4-5). We note that this is similar to Appellants' recognition that "[i]t would be very desirable to provide a device with the advantages of patent 6,683,331 [Francis], but with a reduced on-resistance." (Spec. 0008) (Finding of Fact 4).

With respect to Matsudai and Francis, we also agree with the Examiner that a person of ordinary skill in the art would have known that "phosphorous and arsenic are extremely common elements used to alter a neutral semiconductor material's affinity to a n-type affinity (has an excess of electrons, known as donor atoms)," that phosphorous and arsenic are "two doping elements [which] are basic building blocks of the semiconductor device fabrication process which have been

used since the inception of the semiconductor device," and therefore, it would have been obvious to modify the IGBT of Takahashi with "the 'known benefit' of adding the arsenic / phosphorous dopant atoms to the emitter region / deep diffusion regions (respectively)" in order "to provide materials well known in the art, which would alter the semiconductor material to the desired charge affinity as required by the device set forth by Takahashi." (Ans. 10).

The motivation or suggestion to employ an arsenic dopant in the emitter diffusion region and/or a phosphorous dopant in the deep diffusion region need not be expressly stated in the references, since "[t]he test for an implicit showing is what the combined teachings, knowledge of one of ordinary skill in the art, and the nature of the problem to be solved as a whole would have suggested to those of ordinary skill in the art." *Kahn*, 441 F.3d at 987-88.

The Examiner has provided articulated reasoning with a rational underpinning to support the legal conclusion of obviousness, and there is sufficient motivation and/or suggestion to combine the teachings of Takahashi, Francis, and Matsudai. The motivation and/or suggestion to modify Takahashi comes not only from Francis, but from Appellants' own admissions regarding Francis (*see* Findings of Fact 2 and 4), and common knowledge in the art (*see* Ans. 10 explaining that doping with arsenic and phosphorous is well known and provides known advantages in the field of semiconductors).[3] Appellants do not dispute in

[3] We note that the Advisory Action dated April 3, 2007, provides evidence supporting the proposition that using arsenic and/or phosphorous is known in the semiconductor art to add an excess of donor atoms to create n-type material (Advisory Action, p. 2). The evidence cited and attached by the Examiner in the Advisory Action dated April 3, 2007, states that doping with "an impurity from

their Brief the Examiner's assertion that using arsenic and/or phosphorous dopants to add excess donor atoms and create an n-type material is common knowledge in the art (*see* Br. 4-7).

The Examiner has established a prima facie case of obviousness with respect to claim 1, based on the reasoning as to the combination of Takahashi, Francis, and Matsudai so aptly stated by the Examiner (Ans. 4-5 and 9-10).

Appellants argue that Takahashi does not disclose a trench IGBT including an arsenic-doped emitter diffusion region and a phosphorous-doped deep diffusion region as recited in claim 1 (Br. 5). Appellants cannot show nonobviousness by attacking references individually where rejections are based on a combination of references. *In re Merck & Co., Inc.*, 800 F.2d 1091, 1097 (Fed. Cir. 1986) (citing *In re Keller*, 642 F.2d 413, 425-26 (CCPA 1981)). In the instant case, we are not persuaded by Appellants' argument that Takahashi fails to disclose elements that Francis (*i.e.*, arsenic doped region) and Matsudai (*i.e.*, phosphorous-doped diffusion region) were relied upon as teaching. Likewise, we are not persuaded by Appellants' arguments that Matsudai fails to disclose a phosphorous-doped deep diffusion region (Br. 6-7), when the Examiner has relied upon Matsudai only for a teaching of phosphorous for n-type doping, and not for a "deep" diffusion region. In any event, we find that Francis and Appellants' own admissions reveal that deep diffusion regions are known (Findings of Fact 3 and 5).

We are not persuaded by Appellants' contentions it would not have been

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column V of the periodic table (P [phosphorous], As [arsenic], and Sb)" produces the advantage of introducing "an energy level very near the conduction band in Ge [germanium] or Si [silicon]." BEN G. STREETMAN AND SANJAY BANERJEE, SOLID STATE ELECTRONIC DEVICES § 3.2.4 at 75 (5th ed. 2000).

obvious to combine both the arsenic-doped emitter region of Francis and the phosphorous-doped diffusion region of Matsudai with the IGBT of Takahashi (Br. 5-6), and the Examiner has failed to identify any known benefit to make such a combination (Br. 6). The Examiner's reasoning supports the obviousness of combining the teachings of Takahashi, Francis, and Matsudai (Ans. 4-5 and 9-10), and Appellants allege no criticality or unexpected results flowing from the use of both an arsenic-doped region and a phosphorous-doped region.

Accordingly, Appellants have not overcome the Examiner's prima facie case of obviousness with respect to the rejection of representative claim 1. Appellants' arguments throughout the brief do not convince us of any error in the Examiner's positions in the rejection. *Oetiker*, 977 F.2d at 1445. Claims 2 to 14 fall with claim 1. For all of the above reasons, Appellants' arguments have not persuaded us of error in the Examiner's rejection of claims 1 to 14 under 35 U.S.C. § 103(a) as being unpatentable over Takahashi, Francis, and Matsudai, and we sustain the Examiner's rejection.

CONCLUSION OF LAW

We conclude that the Appellants have not shown that the Examiner erred in rejecting claims 1 to 14 under 35 U.S.C. § 103(a) over the combination of Takahashi, Francis, and Matsudai.

ORDER

We affirm the decision of the Examiner rejecting claims 1 to 14.

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

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