THIS OPINION WAS NOT WRITTEN FOR PUBLICATION

The opinion in support of the decision being entered today (1) was not written for publication in a law journal and (2) is not binding precedent of the Board.

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Paper No. 25

UNITED STATES PATENT AND TRADEMARK OFFICE

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BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

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Ex parte VIREN C. PATEL

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Appeal No. 96-0471
Application 07/995,582[1]

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HEARD: January 13, 1999

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Before THOMAS, KRASS, and BARRETT, Administrative Patent Judges.

BARRETT, Administrative Patent Judge.

DECISION ON APPEAL

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[1] Application for patent filed December 22, 1992, entitled "Structure To Provide Junction Breakdown Stability For Deep Trench Devices."

This is a decision on appeal under 35 U.S.C. § 134 from the final rejection of claims 1, 4-11, and 14-20. Claims 2, 3, 12, and 13 have been canceled.

We reverse.

## BACKGROUND

The disclosed invention is directed to a structure for providing junction breakdown stability for deep trench devices. Appellant discloses that deep trench structures have higher junction breakdown voltages than planar structures, but have the same junction breakdown voltage instability problem that planar junction structures possess. This instability results when oxide-passivated junctions are subjected to conditions which cause avalanche breakdown. Voltage instabilities are caused by surface effects. In deep trenches where the metallurgical junction terminates on the surface of the sidewall, oxide passivated surfaces cause junction breakdown instabilities because they trap charges in the sidewall dielectric (oxide). The invention adds a lightly doped buffer layer adjacent to the sidewalls of the deep trench, thereby shifting the metallurgical junction away from the sidewalls.

Claim 1 is reproduced below.

1. A deep trench transistor structure which provides junction breakdown stability, comprising:

a base region;

a collector region surrounded by a buffer region, wherein the base region rests on top of the buffer region and the collector region;

a deep trench having at least two sidewalls and a floor, wherein the base region extends to the sidewalls; and

> a base-collector junction connecting the base region and the collector region, wherein the buffer region is located adjacent to the sidewalls, thereby shifting the base-collector junction towards the collector region and away from the sidewalls.

The examiner relies on the admitted prior art in appellant's figure 1, described at page 2, lines 11-15, of the specification and the following prior art patent:

Tasch, Jr. et al. (Tasch) 4,153,904 May 8, 1979

Amended drawing figures 2 and 3 are objected to on the basis that the specification does not teach that the boundary between the base region (claim 1) or the first polarity region (claim 11) and the buffer region is a straight line.

The specification is objected to and claims 1, 4-11, and 14-20 stand rejected under 35 U.S.C. § 112, first paragraph, as lacking written description support for the base region extending to the sidewalls of the deep trench as recited in claim 1 and for the first polarity region extending to the sidewalls of the deep trench as recited in claim 11.

Claims 1, 4-11, and 14-20 stand rejected under 35 U.S.C. § 103 as being unpatentable over the admitted prior art and Tasch.[2]

We refer to the Examiner's Answer (Paper No. 16) (pages referred to as "EA__") for a statement of the examiner's position and to the Appeal Brief (Paper No. 14) (pages referred to as "Br__") for a statement of appellant's position.

OPINION

35 U.S.C. § 112, first paragraph, written description

Appellant submits the declaration of Dr. Richard A. Blanchard as evidence that one skilled in the art would have interpreted the drawings and specification to mean that the P+ region extends to the sidewall 40 of the deep trench.

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[2] Claims 9 and 19, which recite "the buffer region is adjacent to the sidewalls and the floor of the trench," were indicated in the first Office action to be allowable if rewritten to overcome the rejection under 35 U.S.C. § 112, second paragraph, and to include all of the limitations of the base claim and any intervening claim (Paper No. 3, page 8). The examiner changed his mind, stating that "[s]ince the claimed subject matter of claims 9 and 19 are well known in the art, it is believed that claims 9 and 19 are also rejected by the Prior art in view of Tasch, Jr. et al." (Examiner's Answer, page 11). Other than this statement, we do not find where the examiner has treated the limitations of claims 9 and 19.

Dr. Blanchard's explanation agrees with our own independent analysis of the specification. The specification, as filed, discloses a modification to the structure of figure 1 wherein the buffer region is added underneath the P+ base region. The examiner's response (EA8-10) is that the portions of the specification relied on by Dr. Blanchard can be interpreted in such a way that the lightly doped buffer region extends up the sidewall and the P+ region extends to the buffer region.

While we understand the examiner's argument, we consider the interpretation strained. For example, page 4 of the specification states: "The primary, or metallurgical junction is moved away from the surface dielectric into the bulk silicon by adding a lightly doped layer adjacent to the deep trench." We agree with Dr. Blanchard that this would be interpreted to mean that "[a] new P-doped region is added adjacent to the P+ doped region already present" (Blanchard declaration, para. 6i). That is, a metallurgical PN junction exists at the sidewall, such as shown in figure 1, to which a lightly doped region is added to move the metallurgical junction away from the sidewall. Accordingly, we find written description support for the limitations that "the base region

extends to the sidewalls [of the deep trench]" (claim 1) and "the first polarity region extends to the sidewalls [of the deep trench]" (claim 11). Although the Board does not normally decide objections, because the objection to the amended drawings is related to the written description rejection, we note our finding that the specification describes a modification of prior art figure 1, which shows a straight line between the P+ base region and the N collector region. The addition of a buffer region would not change this straight line. Therefore, the examiner's objection to the drawings on the basis that the specification does not teach that the boundary between the base region (claim 1) or the first polarity region (claim 11) and the buffer region is a straight line is in error. The § 112, first paragraph, rejection of claims 1, 4-11, and 14-20 is reversed.

35 U.S.C. § 103

The examiner relies on figures 1a to 1c of Tasch. In figure 1a: the claimed "base region" is read on N+ region 21; the claimed "collector region" is read on the raised portion of the P type substrate 10 underneath the N+ region; and the

claimed "buffer region" is read on N doped region 30. Since the raised portion of the P type substrate 10 forming the "collector region" is higher than the bottom of the N doped region 30 forming the "buffer region," Tasch shows "a collector region surrounded by a buffer region." Since the curved perimeter 22 of N+ region 20 forming the "base region" extends into the N doped region 30 forming the "buffer region" and over the P type substrate 10 forming the "collector region," the N+ region 20 "rests on top of the buffer region and the collector region." The raised field oxide layers (not numbered) shown at the sides of figure 1a extend into the substrate and are considered analogous to "a deep trench having at least two sidewalls and a floor." Tasch does not show that the "base region extends to the sidewalls" (i.e., to the field oxide) because the base region curves upward to terminate on the surface 11.

The examiner states (EA6):

> Since both Prior Art (Fig. 1) and Tasch, Jr. et al teach a semiconductor device with a trench formed adjacent to a PN junction, it would have been obvious to one of ordinary skill in the art to have the lightly doped region (P type) of Tasch, Jr. et al in Prior Art because it lowers electric field crowding which results [in] a high avalanche breakdown voltage. (See the abstract of Tasch, Jr. et al).

Appellant argues that there is no suggestion to combine because Tasch is directed to increasing breakdown voltages and not to minimizing junction breakdown voltage instabilities due to surface effects as in the present invention. "[T]he Tasch, Jr. et al. reference could not possibly address the issue of junction breakdown voltage instabilities since the reference itself teaches and discloses the termination of the metallurgical junction on the surface." (Br10.) The examiner responds that Tasch discloses lowering the field crowding, which stabilizes the junction breakdown voltage of a trench-type device, which "is very similar to the objection [sic, object] of the claimed invention" (EA10). The examiner further states (EA11): "[T]he original specification never shows the P+ region extends up to the sidewall of the trench. Therefore, it is not necessary for Tasch to show such a structure."

The examiner's obviousness rejection relies on the § 112, first paragraph, lack of written description rejection in the sense that the examiner states that it is not necessary for Tasch to show the base region (claim 1) or the first polarity region (claim 11) extending to the sidewalls of a trench,

which the examiner found to be without written description support. Since we have reversed the § 112, first paragraph, written description rejection, it is necessary that the combination of the admitted prior art and Tasch suggest the base region extending to the sidewalls of the trench and resting on top of the buffer region. We do not find such a teaching or suggestion in Tasch. Tasch discloses that "[t]he perimeter (i.e. sides) of the doped region extends from the first surface to the bottom of the doped region and has a curvature" (col. 1, lines 21-24). "The curvature is important because the curved geometry causes electric field lines to crowd at the perimeter. Under a high reverse bias voltage, the electric field line crowding gives rise to an avalanche breakdown voltage that is lower than the breakdown voltage of the portion of the doped region with the uniform depth." (Col. 1, lines 25-31.) Tasch solves this problem of breakdown between a first doped region and a substrate <u>in the substrate</u> by adding a second doped region extending laterally away from the first doped region, and having dopant atoms of the same type and less density than the dopant atoms of the first doped region (abstract). Tasch does not disclose or suggest a

buffer region to eliminate breakdown of the base-collector junction at the surface where the metallurgical junction meets the sidewall of the trench. Therefore, we do not find a suggestion in Tasch to modify the admitted prior art to arrive at the claimed subject matter. The § 103 rejection of claims 1, 4-11, and 14-20 is reversed.

CONCLUSION

The rejection of claims 1, 4-11, and 14-20 under 35 U.S.C. § 112, first paragraph, is reversed.

The rejection of claims 1, 4-11, and 14-20 under § 103 is reversed.

REVERSED

JAMES D. THOMAS )
Administrative Patent Judge )
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) BOARD OF PATENT
ERROL A. KRASS ) APPEALS
Administrative Patent Judge ) AND
) INTERFERENCES
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