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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

Ex parte MASASHI SAKAI, YOICHIRO MITANI, and
TAKUYO NAKAMURA

Appeal 2024-004106
Application 16/743,462
Technology Center 2800

Before JENNIFER L. MCKEOWN, BETH Z. SHAW, and
AARON W. MOORE, *Administrative Patent Judges*.

MCKEOWN, *Administrative Patent Judge*.

DECISION ON APPEAL

STATEMENT OF THE CASE

Pursuant to 35 U.S.C. § 134(a), Appellant¹ appeals from the Examiner’s decision to reject claims 1, 2, and 6–9. *See* Final Act. 1. We have jurisdiction under 35 U.S.C. § 6(b).

We REVERSE.

¹ “Appellant” refers to “applicant” as defined in 37 C.F.R. § 1.42. Appellant identifies the real party in interest as MITSUBISHI ELECTRIC CORPORATION. Appeal Br. 2.

CLAIMED SUBJECT MATTER

The claims are directed to silicon carbide epitaxial wafer.

Spec. 1:6–7. The claimed silicon carbide epitaxial wafer

includes a silicon carbide substrate and silicon carbide epitaxial layers formed on the silicon carbide substrate. Each of the silicon carbide epitaxial layers has a triangular defect. The silicon carbide epitaxial layer each have a step inside the triangular defect in the surface morphology of the triangular defect.

Abstract.

Claim 1, reproduced below, illustrates the claimed subject matter:

1. A silicon carbide epitaxial wafer comprising:
 - a silicon carbide substrate; and
 - a silicon carbide epitaxial layer formed on the silicon carbide substrate,wherein the silicon carbide epitaxial layer has a triangular defect and a step inside the triangular defect in a surface morphology of the triangular defect,
 - a first surface of the triangular defect upstream of the step in a step flow direction is lower than a second surface of the triangular defect downstream of the step in the step flow direction, the first surface being lower than the second surface relative to a direction perpendicular to a plane comprising a surface of the silicon carbide epitaxial layer surrounding the triangular defect,
 - the step includes a surface directly connecting the first surface and the second surface and extending from the first surface to the second surface in a direction pointing away from the silicon carbide substrate, and
 - the surface of the silicon carbide epitaxial layer downstream of the triangular defect is higher than the first surface and the second surface relative to the direction perpendicular to the plane.

REJECTIONS

The Examiner maintains the following rejections:

Claims 1, 2, and 6–9 are rejected under 35 U.S.C. § 112(a) as failing to comply with the written description requirement. Final Act. 4.

Claims 1, 2, and 6–9 are rejected under 35 U.S.C. § 112(b) as being indefinite. Final Act. 10.

OPINION

THE WRITTEN DESCRIPTION REJECTION

Claims 1, 2, and 6–9

The Examiner finds lack of written description support for (1) “a first surface of the triangular defect upstream of the step in a step flow direction is lower than a second surface of the triangular defect downstream of the step in the step flow direction” (hereafter “height difference limitation”) (Final Act. 4); (2) “the first surface being lower than the second surface relative to a direction perpendicular to a plane comprising a surface of the silicon carbide epitaxial layer surrounding the triangular defect” (hereinafter “surface plane limitation”) (Final Act. 7); (3) “the step includes a surface directly connecting the first surface and the second surface and extending from the first surface to the second surface in a direction pointing away from the silicon carbide substrate” (hereinafter “step direction limitation”) (Final Act. 8); and (4) “the surface of the silicon carbide epitaxial layer downstream of the triangular defect is higher than the first surface and the second surface relative to the direction perpendicular to the plane” (hereinafter “downstream limitation”). Final Act. 8–9.

In assessing written description, we consider “whether the disclosure of the application relied upon reasonably conveys to those skilled in the art

that the inventor had possession of the claimed subject matter as of the filing date sought.” *Ariad Pharm., Inc. v. Eli Lilly and Co.*, 598 F.3d 1336, 1351 (Fed. Cir. 2010) (*en banc*). This “test requires an objective inquiry into the four corners of the specification from the perspective of a person of ordinary skill in the art. Based on that inquiry, the specification must describe an invention understandable to that skilled artisan and show that the inventor actually invented the invention claimed.” *Id.* at 1351. Under this standard, for the reasons discussed below, we are persuaded of error in the Examiner’s rejection.

(1) “a first surface of the triangular defect upstream of the step in a step flow direction is lower than a second surface of the triangular defect downstream of the step in the step flow direction”

The Examiner provides four reasons why this height difference limitation fails to comply with the written description requirement. First, the Examiner identifies that the Specification describes the silicon carbide substrate has an off angle and the claimed relative height difference does not consider this off angle. Final Act. 5; *see also* Spec. 5:20 (disclosing that the substrate “off angle is about 5° or less.”).

Second, the Examiner points out that the Specification describes the height difference in the second silicon carbide epitaxial layer, not in the triangular defect. Final Act. 4–5.

Third, the Examiner finds the Specification only describes the height difference with respect to the step as a “portion” of the second silicon carbide epitaxial layer. As such, this “portion” may be limited to the immediate and narrow portion of the silicon carbide layer directly adjacent

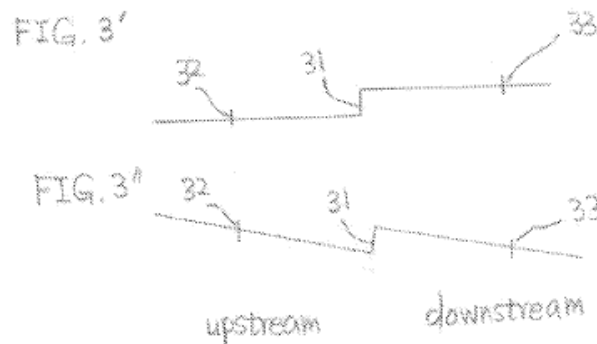
to the step and does not describe the *entire* portion of the triangular defect before the step is lower than the *entire* portion of the triangular defect after the step. Final Act. 5–6.

Finally, the Examiner maintains that the top view of Figure 3 alone does not sufficiently show the claimed height difference and, thus, the Appellant is “attempting to claim [] an opinion, a misrepresentation or misinterpretation, or an overinterpretation of the single micrograph shown in Fig. 3 of current application.” Final Act. 6–7; *see also* Ans. 4 (finding that Appellant relies on conjecture “rather than from actual measurement results” and that the “low resolution micrograph” of Figure 3 does not clearly show the detailed features or overall size of the claimed triangular defect). Similarly, in the Answer, the Examiner maintains that Figure 3 is insufficient because “there is no way to unambiguously tell whether the plane in Fig. 3 of the current application is aligned with any structural element of the claimed invention.” Ans. 3. *See also* Ans. 6–8 (citing prior art top view figures to show that a top view is insufficient to depict a height difference).

Based on the record before us, we are persuaded of error in the Examiner’s determination. First, the Examiner here does not sufficiently explain *why* an off angle in the silicon carbide substrate shows lack of written description support for the claimed relative height difference. Appeal Br. 4. The Specification describes the silicon carbide epitaxial layer, which includes first and second silicon carbide epitaxial layers, is formed on the substrate. *See, e.g.*, Spec. Fig. 1; 5:21–23. The Specification then describes the height difference of the *surface* of the formed *epitaxial layer*. *See, e.g.*, Spec. 11:18–21 (disclosing a portion of the *surface of the epitaxial layer* on

the left side of the step is lower than a portion of the *surface of the epitaxial layer* on the right side of the step). The surface plane limitation similarly refers to the plane of the *surface of the epitaxial layer*. It is unclear, based on the record before us, why a substrate off angle results in lack of written description support for the recited height difference of the first surface and second surface of the triangular defect in the epitaxial layer.

For example, in the Examiner's annotated hand drawn schematic side views of Figure 3, namely Fig. 3' and 3'' (Ans. 14) reproduced below, the plane of the surface of the epitaxial layer, i.e. the plane corresponding to the line with point 33, *tilts with* the depicted off angle.



**Examiner's Hand Draw Schematic Side Views of Figure 3,
With and Without an Off Angle**

As such, contrary to the Examiner's assertion, in Fig. 3'' point 32 is lower than point 33 relative to a direction perpendicular to the depicted *tilted* plane corresponding to the surface of the silicon carbide epitaxial layer. Therefore, the Examiner has not shown that the Specification's disclosure of a substrate off angle results in a lack of written description support for the recited height difference limitation.

We likewise disagree with the Examiner's second reason that the surface height difference is described as *outside* the triangular defect. *See*

e.g., Ans. 5. The claim itself recites the step is “inside the triangular defect.”

Appeal Br. 16. The Specification also, with reference to Figure 3, describes

the surface of the second silicon carbide epitaxial layer 13 on the left side of the step 31, that is, a portion before the step 31 along the step flow direction, is lower than the surface of the second silicon carbide epitaxial layer 13 on the right side of the step 31, that is, a portion after the step 31 along the step flow direction.

11:18–21. While this disclosure refers to a surface of the second silicon carbide epitaxial layer or a portion of the layer, Figure 3, reproduced below, notably depicts cited step 31 *only within* triangular defect 30. *See* Reply Br. 3.

F I G. 3

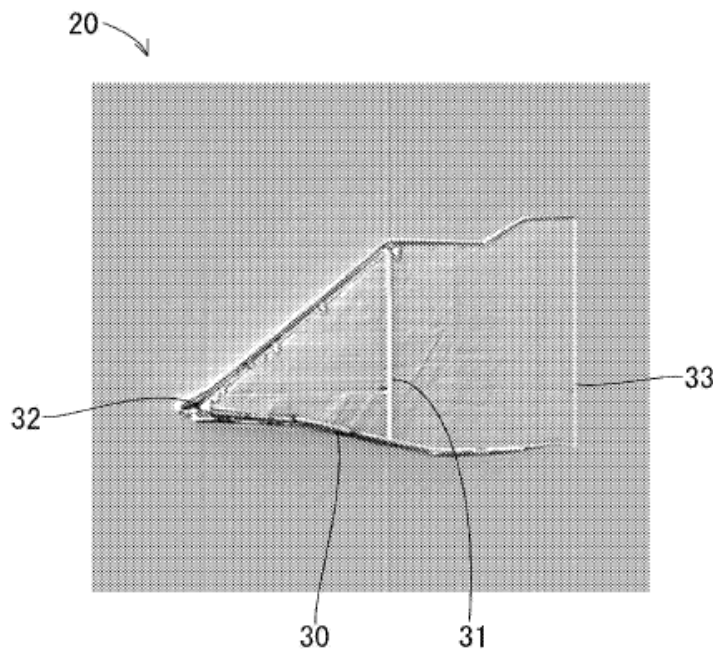


Figure 3 Depicting a Photograph of an Exemplary Triangular Defect Present in the Silicon Carbide Epitaxial Wafer Observed with an Optical Surface Defect Evaluation Apparatus

See also Spec. 4:8–10 (disclosing “a step *inside* the triangular defect in the surface morphology of the triangular defect.” (emphasis added)). As such, contrary to the Examiner’s annotated Figure 3 in the Answer (Ans. 5), a skilled artisan would understand that the Specification describes a surface *within* the triangular defect and sufficiently supports the claimed limitation.

Regarding reason three, the claim does not recite the “entire” triangular defect on each side of the step, but instead recites “a first surface” and “a second surface” of the triangular defect. In other words, in view of the Specification including Figure 3, a portion of the surface of the triangular defect upstream of the step is lower than a portion of a surface of the triangular defect downstream to the step. As such, the Examiner’s reasoning fails to show lack of written description support.

Finally, regarding reason four, the Examiner finds Figure 3 *alone* does not sufficiently describe the claimed height difference. *See, e.g.*, Final Act. 6 (finding that Appellant is attempting to claim a misrepresentation of a single micrograph of Figure 3); Ans. 6–7 (repeating that a top view photograph cannot show a height difference). As Appellant points out though, the Examiner’s reasoning is “especially inadequate considering that page 11, lines 11-13 and 18-21 of the instant specification explicitly describe the features of claim 1.” Reply Br. 3. *See also* Reply Br. 5 (“the Examiners’ additional arguments regarding measurement conditions and the ‘size of the micrograph’ are inadequate to establish that the disclosure fails to demonstrate possession of the claimed features”).

We agree. While a side view may generally provide additional detail, the lack of a side view or lack of measurement conditions, without more, does not establish insufficient written description, particularly here, where

the Specification explicitly describes the height difference with respect to Figure 3. *See* Spec. 11:11–21. As such, based on the record before us, we are constrained to find that the Examiner does not demonstrate insufficient written description support for the recited height difference limitation.

(2) “the first surface being lower than the second surface relative to a direction perpendicular to a plane comprising a surface of the silicon carbide epitaxial layer surrounding the triangular defect”

The Examiner finds that the Specification does not disclose “what the ‘plane comprising a surface of the epitaxial layer’ would be” or, in other words, the Specification does not disclose that the triangular defect and the remaining surface area of the silicon carbide epitaxial layer have the same surface orientation. Final Act. 7; Reply Br. 3. The Examiner also finds that the Specification does not describe “how the etching is carried out” or “the surface orientation of the etched surface of the triangular defect.” Final Act. 7.

As discussed above, the Specification describes forming the silicon carbide epitaxial layer on the substrate and describes the recited height difference with respect to Figure 3. *See, e.g.*, Spec. Fig. 1; 5:21–23; 11:11–21. This surface plane limitation merely identifies the height difference with reference to a plane aligned with or corresponding to the surface of this epitaxial layer. Based on the record before us, the Examiner does not sufficiently explain how lack of description of the etching process or surface orientation of the triangular defect demonstrate lack of written description support for this limitation. *See, e.g.*, Appeal Br. 6–7. Based on the record

before us, we are constrained to find that the Examiner’s reasoning does not show lack of written description support for the surface plane limitation.²

(3) “the step includes a surface. . . extending from the first surface to the second surface in a direction pointing away from the substrate”

The Examiner explains “this limitation appears to suggest that the silicon carbide substrate has a flat surface without an off angle” and “appears to suggest ‘in a direction perpendicular to the substrate.’” Final Act. 8. According to the Examiner, because of the described substrate off angle, the surface should instead “extend along a direction forming an oblique angle with respect to the substrate.” Final Act. 8. The Examiner also notes that the Specification does not include the word “away” in the original disclosure. Final Act. 8.

We agree with Appellant that the Examiner’s interpretation is unreasonably narrow. Appeal Br. 7. It is unclear, based on the record before us, why pointing in a direction “away from the substrate” would require a direction perpendicular to the substrate. For example, the oblique angle noted by the Examiner *also* is a direction pointing away from the substrate. As Appellant also points out, there is no verbatim requirement to satisfy the written description requirement. Reply Br. 4. *See Purdue Pharma L.P. v. Faulding Inc.*, 230 F.3d 1320, 1323 (Fed. Cir. 2000) (“In order to satisfy the written description requirement, the disclosure as originally filed does not

² We also note that Appellant’s petition requesting withdrawal of the Examiner’s objection to the drawings for failing to show this limitation was granted. The petition found the limitation is illustrated in Figure 3 and described on pages 4–5 of the Specification. Decision Granting Petition on April 3, 2024, Control. No. 16/743,462, at 3–4.

have to provide *in haec verba* support for the claimed subject matter at issue.”).

With respect to the substrate off angle, as discussed above, the Examiner’s reasoning is misplaced. Namely, it is unclear how the substrate off angle would show lack of possession of the claimed step direction limitation. Based on the record before us then, we are constrained to find that the Examiner, without more, fails to sufficiently show lack of written description support for the step direction limitation.

(4) “the surface of the silicon carbide epitaxial layer downstream of the triangular defect is higher than the first surface and the second surface relative to the direction perpendicular to the plane”

The Examiner finds that there is an inconsistency in the claim language in that the claim recites the surface of the epitaxial layer *surrounding* the triangular defect (previous limitation) is *downstream* of the triangular defect (this limitation). Final Act. 9. In other words, the surface of the epitaxial surface downstream of the triangular defect does not surround the triangular defect. The Examiner also finds there is no antecedent basis for the surface downstream the triangular defect. Final Act. 9.

The Examiner next finds that Appellant merely claims “their opinion or impression of the single micrograph shown in Fig. 3 of current application rather than an actual structure.” Final Act. 9. In the Answer, the Examiner again explains that the micrograph of Figure 3 is insufficient to show the disputed claim limitations because Appellant’s Specification does not disclose the size or measurement conditions of the micrograph nor does the

Specification describe the type of scientific tool used to create the micrograph. Ans. 3.

For similar reasons to those discussed above, we are persuaded of error in the Examiner's determination. For example, while we agree there is an inconsistency in reciting a surface of the epitaxial layer *surrounding* the triangular defect as the antecedent basis for *the* surface of the epitaxial layer *downstream* of the triangular defect, the Examiner fails to sufficiently explain *why* this inconsistency in antecedent basis establishes lack of written description. As Appellant explains, Figure 3 at least depicts a surface of the epitaxial layer *surrounding* the triangular defect that would include a surface of the epitaxial layer *downstream* of the triangular defect. *See* Appeal Br. 8–9; Spec. Fig. 3; 11:10–21. Similarly, as discussed above, the Examiner's speculation regarding structures, based on other prior art references, does not show lack of written description in the present Specification. *See* Reply Br. 3. Based on the record before us then, we are constrained to find that the Examiner has not established lack of written description support for the downstream limitation.³

Accordingly, we reverse the rejection of claims 1, 2, and 6–9 under 35 U.S.C. § 112(a) as failing to comply with the written description requirement.

³ We again note that Appellant's petition requesting withdrawal of the Examiner's objection to the drawings for failing to show this limitation was granted. The petition found the limitation is illustrated in Figure 3 and described on pages 4–5 of the Specification. Decision Granting Petition on April 3, 2024, Control. No. 16/743,462, at 3–4.

THE INDEFINITENESS REJECTION
Claims 1, 2, and 6–9

“[A] claim is indefinite when it contains words or phrases whose meaning is unclear,” and “claims are required to be cast in clear--as opposed to ambiguous, vague, indefinite--terms.” *In re Packard*, 751 F.3d at 1310, 1313 (Fed. Cir. 2014) (per curiam). In assessing whether a claim is indefinite, we determine whether those skilled in the art would have understood what is claimed when the claim is read in light of the Specification. *See Orthokinetics, Inc. v. Safety Travel Chairs, Inc.*, 806 F.2d 1565, 1576 (Fed. Cir. 1986).

The Examiner determines the height difference limitation, the step direction limitation, and claim 8 are indefinite because of the lack of consideration of a substrate off angle. *See, e.g.*, Final Act. 11 (finding “away from the substrate” implies in a direction perpendicular to the substrate but this is inconsistent with disclosure of a substrate off angle); Final Act. 15 (finding that the limitations of claim 1 and 8 suggest there is no substrate off angle); Final Act. 16–17 (determining claim 8 indefinite because of the disclosed substrate off angle). The Examiner also determines these limitations are indefinite because of lack of written description. *See, e.g.*, Final Act. 15 (supporting the indefiniteness rejection and explaining “1 and 8 also fail to comply with the written description requirement.”); Ans. 12 (“[C]laim 1 fails to comply with the written description requirement, and therefore, it is not clear whether the cited limitations of claims 1 and 8 would require zero offcut angle.”).

Notably, the claims here do not recite a substrate off angle and the Examiner fails to sufficiently explain *why* a substrate off angle would render these recited limitations indefinite. As Appellant explains,

regardless of any off angle, the claimed “first surface” in FIG. 3 would be “lower than the second surface relative to a direction perpendicular to a plane comprising a surface of the silicon carbide epitaxial layer surrounding the triangular defect” as claimed.

Nothing about this recitation is indefinite. Rather, the Examiner merely inserts potential limitations into the claim regarding an offcut or off-axis angle and then incorrectly asserts that it is unclear whether the claim language requires these additional limitations.

Appeal Br. 13. *See also* Appeal Br. 14 (with respect to claim 8 pointing out that the Examiner again “is inserting limitations into the claim regarding an offcut or off-axis angle to then assert that it is unclear whether modifying a structure to include such limitations could read on the claim language” and maintaining that “claim 8 is definite, especially when considered in light of the present disclosure.”). Similarly, the Examiner does not explain why the alleged lack of written description of a substrate off angle renders these claim limitations indefinite. As also discussed above, we are persuaded the Examiner erred in finding the claimed limitations fails to comply with the written description requirement. As such, based on the record before us, we are persuaded of error in the Examiner’s indefiniteness determination as to these limitations.

With respect to the height difference limitation and the surface plane limitation, the Examiner finds it is not clear “whether these two limitations can be interpreted separately” and also “these two limitations are not necessarily linked to each other.” Final Act. 11. The surface plane limitation though expressly recites “the first surface” and “the second surface” of the height difference limitation and, thus, there is a clear link between the limitations. Appeal Br. 10. As such, based on the record before us, we are

similarly persuaded of error in the Examiner's indefiniteness determination as to these limitations.

Finally, the Examiner determines the recited "triangular defect" is indefinite because the defect in Figure 3 is not triangular in shape but instead has a complex shape with a triangle on the left hand side. Final Act. 11–12. The Examiner reasons "any arbitrary defect such as a pentagonal or hexagonal defect can also be referred to as "a triangular defect" since a pentagonal or hexagonal defect has a triangular shape on a portion of the pentagonal or hexagonal defect." Final Act. 12. The Examiner finds that Appellant's submitted declaration "simply made allegations that one of ordinary skill in the art would be able to know what the claimed triangular defect is without explaining what the claimed triangular defect is." Final Act. 17. In the Answer, the Examiner further explains "one of ordinary skill in the art would not know whether the alleged triangular defect has a triangular shape in a part of the defect as shown in Fig. 3 of current application, or the entirety of the defect should have an approximately triangular shape overall." Ans. 11.

We agree with Appellant that the Examiner "improperly conflates breath of the claim with indefiniteness." Appeal Br. 12. As Appellant explains, "the claims are not required to delimit the exact shape of the triangular defect." Appeal Br. 12. Appellant, in particular, submits "one of ordinary skill in the art would understand that a 'triangular defect' is a term of art meaning a defect having a substantially triangular shape with an apex upstream in the step flow direction and a base downstream in the step flow direction." Appeal Br. 11; *see also* Declaration under 37 C.F.R. § 1.132 by Yoichiro Mitani, filed October 13, 2023. While the Examiner generally finds

this definition insufficient (Final Act. 17), the Examiner does not explain why this definition is indefinite or why this definition would be unreasonable. As such, based on the record before us, we are persuaded of error in the Examiner's indefiniteness determination.

Accordingly, we reverse the rejection of claims 1, 2, and 6–9 under 35 U.S.C. § 112(a) as indefinite.

CONCLUSION

We reverse the rejection of claims 1, 2, and 6–9 under 35 U.S.C. § 112(a) as failing to comply with the written description requirement and reverse the rejection of claims 1, 2, and 6–9 under 35 U.S.C. § 112(a) as indefinite.

DECISION SUMMARY

The following table summarizes our decision:

Claim(s) Rejected	35 U.S.C. §	Reference(s)/ Basis	Affirmed	Reversed
1, 2, 6–9	112	Written Description		1, 2, 6–9
1, 2, 6–9	112	Indefiniteness		1, 2, 6–9
Overall Outcome				1, 2, 6–9

REVERSED