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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

Ex parte RADEK ROUCKA, MICHAEL LEBBY,
and SCOTT SEMANS

Appeal 2015-004467
Application 13/619,736
Technology Center 2800

Before GEORGE C. BEST, DONNA M. PRAISS, and
JULIA HEANEY, *Administrative Patent Judges*.

PRAISS, *Administrative Patent Judge*.

DECISION ON APPEAL[1]

STATEMENT OF CASE

Appellants[2] appeal under 35 U.S.C. § 134 from the Examiner's decision to reject claims 1, 2, 4, 5, 7, 9, 11, 12, 14, 15, 17, and 19 under 35 U.S.C. § 103(a) as follows:

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[1] In this decision, we refer to the Specification filed September 14, 2012 (Spec.), the Final Office Action appealed from mailed March 28, 2014 (Final Act.), the Appeal Brief filed October 20, 2014 (App. Br.), the Examiner's Answer mailed December 29, 2014 (Ans.), and the Reply Brief filed March 2, 2015 (Reply Br.).

[2] The real party in interest is identified by Appellants as Translucent Inc. App. Br. 2.

1. Claims 1, 2, 5, 7, 11, 12, 15, and 17 over Clark[3] and Hack[4]; and

2. Claims 4, 9, 14, and 19 over Clark, Hack, and Kouvetakis.[5]

We have jurisdiction under 35 U.S.C. § 6(b).

We AFFIRM.

The invention relates to the deposition of IV semiconductor material on silicon wafers with a rare earth structure between the IV material and the silicon substrate. Spec. 1. Claims 1 and 4 are illustrative (subject matter in dispute italicized):

> 1. A method of fabricating IV materials on a silicon substrate comprising the steps of:
>
> providing a crystalline silicon substrate;
>
> epitaxially growing a rare earth structure on the silicon substrate; and
>
> epitaxially growing a single crystal IV material film on the rare earth structure, the single crystal IV material film including at least a layer of single crystal GeSn and *the step of growing the single crystal IV material including using a grading profile to grade Sn through the single crystal GeSn layer*.
>
> 4. A method as claimed in claim 1 wherein the step of growing at least the layer including GeSn includes *growing the graded single crystal GeSn layer with a thickness in a range of approximately 3μm to approximately 5μm.*

Claims App'x at App. Br. 31, 32.

Appellants do not separately argue the patentability of dependent claims 4, 9, 14, and 19. App. Br. 27–29. In accordance with 37 C.F.R. § 41.37(c)(1)(iv), claims 9, 14, and 19 will stand or fall together with claim 4.

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[3] Clark et al., US 2010/0109047 A1, published May 6, 2010 ("Clark").
[4] Hack et al., US 4,547,621, issued Oct. 15, 1985 ("Hack").
[5] Kouvetakis, US 2011/0198729 A1, published Aug. 18, 2011.

OPINION

Claim 1 over Clark and Hack

Regarding claim 1, the Examiner finds that Clark discloses a crystalline silicon substrate, epitaxially growing a rare earth structure on the silicon structure, and epitaxially growing a single crystal IV material such as germanium film on the rare earth structure. Final Act. 2 (citing Clark ¶¶ 40, 45, Fig. 2C). The Examiner also finds that it would have been obvious to one of ordinary skill in the art at the time of the invention to use Hack's germanium alloy compositionally graded with tin (Sn) in order to narrow the IV material's band gap. *Id.* at 3 (citing Hack 16:40–45).

Appellants contend that the Examiner's rejection of claim 1 is in error because (1) "[i]n view of prior attempts to add tin to germanium compounds, . . . any schemes proposed must show substantial proof of a reasonable expectation of success[,]" (2) Hack teaches amorphous material and "amorphous material and single crystal or crystalline material are substantially different and require substantially different processes for fabrication[,]" (3) "[n]one of the amorphous materials of Hack et al. could be incorporated into the single crystal structure of Clark et al. since there could be no lattice matching, which is critical to the disclosure and invention of Clark et al.[,]" and (4) Clark does not suggest that "all of the various forms [of germanium alloy] listed [in Clark] are similar in the art or otherwise, only that they can exist." App. Br. 10–15.

The Examiner responds that paragraphs 8 and 26 of Clark evidence that "the disclosed layers of group IV materials may comprise crystalline or amorphous materials[,]" that the materials "are compatible with known processing techniques[,]" that "Hack teaches that germanium alloys (similar

to the IV material of Clark) may be compositionally graded with Sn in order to modify the band gap, and therefore it would have been obvious to grade the IV material of Clark with Sn with an expectation of success (i.e. in tuning the band gap of Clark)." Ans. 2. The Examiner finds that an expectation of success is evidenced by Clark and Hack which both describe amorphous and crystalline material being similar, as well as "Kouvetakis (¶13, ¶30), which recites that Sn may be added to Ge (IV material) in order to modify the lattice constant and band gap of the IV material." Ans. 3. The Examiner further finds that Kouvetakis teaches the claimed thickness of a graded layer of GeSn. Final Act. 5, 6.

In the Reply Brief, Appellants argue that paragraphs 8 and 26 of Clark do not "suggest[] to one of ordinary skill in the art that the amorphous material of Hack et al. could be mixed with the crystalline material of Clark et al." Reply Br. 2. Appellants acknowledge that amorphous semiconductor devices are substantially equivalent to their crystalline counterparts in operation as taught by Hack, but "[A]ppellants are stating unequivocally that layers of amorphous and crystalline material cannot be intermixed and nothing in either Clark et al. or Hack et al. in any way suggests they can be." *Id*. at 3. Appellants further argue that "[a]ny person of ordinary skill in the art interested in photovoltaic cells as taught by Clark et al. would find no motivation in narrowing the band gap of semiconductor material by adding amorphous tin as taught by Hack et al." *Id*. at 4.

We are not persuaded by Appellants' arguments and find that the preponderance of the evidence supports the rejection of claim 1 for the reasons provided by the Examiner in the Final Action and the Answer. Final Act. 2–3, 6; Ans. 2–4. We add the following for emphasis.

Appellants' arguments are unpersuasive because the Examiner correctly finds that Clark teaches that crystalline and amorphous forms of IV materials are encompassed by Clark's disclosure, as well as mixtures thereof, not merely that such forms exist. Clark ¶ 8. We are not persuaded that the disclosure in Clark is limited to crystalline lattice structures as Appellants argue. Clark explicitly states "[d]isclosed layers are, optionally, single crystal, multi-crystalline or amorphous layers and compatible with semiconductor processing techniques." Clark ¶ 26. Therefore, Clark does not exclude amorphous layers of IV material in its method. Clark further teaches that "'[a] layer' may also comprise multiple layers." *Id.* Clark's disclosure thus broadly describes the use of both crystalline and amorphous layers in the IV material layer. Appellants provide only attorney argument regarding the significance of amorphous and crystalline forms of IV materials which is insufficient to rebut the evidence cited by the Examiner. It is well settled that arguments of counsel cannot take the place of factually supported objective evidence. *See, e.g.*, *In re Huang*, 100 F.3d 135, 139–40 (Fed. Cir. 1996); *In re De Blauwe*, 736 F.2d 699, 705 (Fed. Cir. 1984).

We also find Appellants' arguments unpersuasive because claim 1 does not preclude the presence of an amorphous IV material film nor is claim 1 limited to photovoltaic cells in any way. Accordingly, the Examiner's reason for combining the germanium alloy compositionally graded with tin (Sn) in order to narrow the band gap of the IV material, as taught by Hack, with Clark's device has a rational underpinning. Moreover, Appellants acknowledge that amorphous semiconductor devices are substantially equivalent to their crystalline counterparts in operation. Reply Br. 3.

Appellants' argument that the Examiner has not shown "substantial proof of a reasonable expectation of success" (App. Br. 11) in using Hack's teaching to grade the germanium alloy with tin is unpersuasive because the Examiner has presented both Hack and Kouvetakis as evidence that germanium alloy graded with tin has a reasonable expectation of success in terms of either reducing band gap or achieving sufficient thickness to meet the range recited in dependent claim 4. Appellants have not adequately rebutted the Examiner's evidence on this record.

In sum, Appellants have not persuaded us of reversible error in the Examiner's finding that Hack provides a reason for modifying Clark's method of fabricating IV materials on a silicon substrate and that there is a reasonable expectation of success in reducing the band gap of the IV material.

Claims 2, 5, 7, 11, 12, 15, and 17 over Clark and Hack

Appellants contend that the Examiner's rejection of claims 2, 5, 7, 11, 12, 15, and 17 is in error essentially for the same reasons discussed above in connection with claim 1. App. Br. 17–27. Appellants add that because Clark does not teach GeSn, "Clark et al. could not, therefore, suggest crystal lattice matching or crystal lattice mismatching nor could they suggest providing a stressed single crystal IV material film that is either compressive or tensile stressed" as required by dependent claim 2. *Id.* at 17. This argument is not persuasive because Appellants do not explain why Clark's teachings of crystal lattice matching or mismatching using a germanium alloy would not instruct one of ordinary skill in the art of crystal lattice

matching or mismatching using a germanium alloy as modified by Hack. Final Act. 3 (citing Clark ¶¶ 10, 40, 41).[6]

Regarding dependent claim 5, which depends from claim 1 and recites "incorporating a rare earth oxide with electrical insulating characteristics," Appellants add that "[s]ince Clark et al. only disclose a solar cell, they could not possibly suggest the advantages and improvements of the present invention as specified in claim 5." App. Br. 18–19. This argument is not persuasive because Appellants do not dispute that Clark discloses the use of rare earth oxide in its rare earth structure that is a stressed layer adjacent an insulating layer. Final Act. 3; Clark ¶¶ 35, 40 and Fig. 14B, item 1410.

Regarding independent claim 7, which incorporates the requirements of claims 1, 2, and 5 discussed above, Appellants argue that "[n]othing in the teachings of Clark et al. and/or Hack et al. suggests a method to overcome the deficiencies of the prior art or in any way suggest grading Sn through the single crystal layer." App. Br. 21. This argument is not persuasive because it does not adequately rebut the Examiner's finding that Hack provides a reason for modifying the IV material layer of Clark to reduce the band gap.

Regarding independent claim 11, which is directed to a device having the components recited in claim 1, Appellants assert that "substantial proof of a reasonable expectation of success" is required because "the addition of tin to germanium makes it very difficult to grow sufficiently thick single crystal layers of material" and nothing in the combination of Clark and Hack

[6] If prosecution continues, we note that dependent claim 2 does not appear to further limit claim 1 from which it depends as required by 35 U.S.C. § 112(d). In both claims 1 and 2, the lattice of the single crystal IV material film is either matched or mismatched to the rare earth structure and providing one of an unstressed or a stressed single crystal IV material film.

"suggest[s] grading Sn through the single crystal layer." App. Br. 21–22. This argument is not persuasive for the reasons discussed above in connection with claim 1.

Regarding claim 12, which depends from claim 11 and requires that the single crystal IV material film includes one of being crystal lattice match or crystal lattice mismatched to the rare earth structure, Appellants argue that this limitation would not have been obvious because "Clark et al. do not suggest an epitaxially grown layer of single crystal GeSn and the single crystal IV material including graded Sn through the single crystal GeSn layer." App. Br. 23. This argument is not persuasive because the rejection is not over Clark alone, nor is Clark cited for teaching Sn graded germanium.[7] Hack is cited for teaching that Sn graded germanium reduces the band gap of the IV material.

Regarding claim 15, which depends from claim 11 and requires that the rare earth structure includes a rare earth oxide with electrical insulating characteristics, Appellants add that "[s]ince Clark et al. only disclose a solar cell, they could not possibly suggest the advantages and improvements of the present invention as disclosed for the invention in claim 15." App. Br. 24. This argument is not persuasive because Appellants do not dispute that Clark discloses the use of rare earth oxide in its rare earth structure that is a stressed layer adjacent an insulating layer. Final Act. 3; Clark ¶¶ 35, 40 and Fig. 14B, item 1410. Moreover, Appellants concede that "many of the rare

[7] If prosecution continues, we note that dependent claim 12 does not appear to further limit claim 11 from which it depends as required by 35 U.S.C. § 112(d). In both claims 11 and 12, the lattice of the single crystal IV material film is either matched or mismatched to the rare earth structure and providing one of an unstressed or a stressed single crystal IV material film.

earth oxides provide very good electrical insulation or dielectric characteristics . . . ." App. Br. 24. Therefore, the characteristics of the rare earth oxide required by claim 15 would be inherently possessed by the materials disclosed in Clark.

Regarding claim 17, which incorporates the requirements of claims 11, 12, and 15 discussed above, Appellants assert that "substantial proof of a reasonable expectation of success" is required in view of prior attempts to add tin to germanium described in the Specification and nothing in the combination of Clark and Hack "suggest[s] grading Sn through the single crystal layer." App. Br. 25–27. We are not persuaded by Appellants' arguments for the same reasons discussed above in connection with claims 1, 11, 12, and 15. Appellants also assert that claim 17 requires a rare earth oxide with electrical insulating characteristics that provide electrical insulation from the silicon substrate and "[s]ince Clark et al. only disclose a solar cell, they could not possibly suggest the advantages and improvements of the present invention as specified in claim 17." *Id.* at 26.

Claim 4 over Clark, Hack, and Kouvetakis

Regarding claim 4, the Examiner finds that the device of Clark as modified by Hack does not disclose a graded single crystal GeSn layer with a thickness in a range of approximately 3μm to approximately 5μm. Final Act. 5. The Examiner further finds that Kouvetakis teaches a graded layer of GeSn may have a thickness of 50nm to 10μm. *Id.* (citing Kouvetakis ¶ 29). In the absence of any evidence in this record of criticality in the thickness of the GeSn layer, the Examiner finds that the dimension of the IV material layer would have been obvious to an ordinary artisan practicing the invention and a matter of routine experimentation. *Id.*

Appellants contend that the Examiner's rejection of claim 4 is in error because (1) Kouvetakis does not correct the deficiencies of Clark and Hack identified with respect to claim 1, (2) "Kouvetakis et al. only teach the formation of a GeSn layer directly on the substrate[,]" and (3) "the three disclosures cannot be combined since any combination would render the basic structure unsatisfactory for its intended purpose." App. Br. 28–29.

The Examiner responds that "[n]either Hack nor Kouvetakis teaches away from adding Sn to the germanium layer of Clark, and it would have been obvious to do so in order to tune the band gap of Clark." Ans. 4.

In the Reply Brief, Appellants state that "appellants never stated that either [H]ack et al. or Kouvetakis et al. 'teach away from adding Sn to the germanium layer of Clark'" and contend that nothing in the references suggest their combination. Reply Br. 4–5.

We are not persuaded by Appellants' arguments because they are conclusory. Appellants do not adequately explain why the teaching of Hack to grade germanium with Sn to reduce the band gap of a device does not suggest modifying the germanium layer of Clark. In addition, Appellants do not adequately explain why the teachings of Kouvetakis regarding the thickness of a GeSn layer would render the combination "unsatisfactory for its intended purpose." App. Br. 28–29. Appellants do not dispute the Examiner's finding that there is no criticality of the claimed thickness and, therefore, the thickness taught by Kouvetakis evidences an expectation of success in achieving that thickness in the device of Clark as modified by Hack though routine experimentation.

In sum, Appellants have not persuaded us of a reversible error in the Examiner's finding that Hack provides a reason for modifying Clark's

method of fabricating IV materials on a silicon substrate and that there is a reasonable expectation of success in achieving the claimed thickness of the Sn graded IV material based on the teachings of Kouvetakis.

CONCLUSION

We sustain the Examiner's rejections.

DECISION

The Examiner's decision is affirmed.

TIME PERIOD FOR RESPONSE

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