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Baker Botts L.L.P.
98 San Jacinto Blvd
Suite 1500
Austin, TX 78701

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juli.tran@bakerbotts.com
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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

Ex parte PAUL S. HO
and ZHUOJIE WU

Appeal 2019-000036
Application 15/040,025
Technology Center 2800

Before GEORGE C. BEST, DONNA M. PRAISS, and LILAN REN, *Administrative Patent Judges*.

PRAISS, *Administrative Patent Judge*.

DECISION ON APPEAL[1]

Pursuant to 35 U.S.C. § 134(a), Appellant appeals from the Examiner's decision to reject claims 1, 4–22, and 31.[2] We have jurisdiction under 35 U.S.C. § 6(b).

We AFFIRM.

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[1] In this Decision, we refer to the Specification filed Feb. 10, 2016 ("Spec."), the Non-Final Office Action dated Oct. 26, 2017 ("Non-Final Act."), the Appeal Brief filed Mar. 26, 2018 ("Appeal Br."), and the Examiner's Answer dated July 31, 2018 ("Ans.").

[2] We use the word "Appellant" to refer to "applicant" as defined in 37 C.F.R. § 1.42. Board of Regents, The University of Texas System is identified as the real party in interest. Appeal Br. 3.

STATEMENT OF THE CASE

The invention relates to methods of fabricating silicon nanowires. Spec. 1:4. According to the Specification, silicon nanowires show promise for use in applications such as nanoelectronics, opto-electronics, electromechanical devices, energy conversion and storage, biological and chemical sensors, and drug delivery devices. *Id.* at 1:13–16. The Specification states that there is a need for a cost-effective process for fabricating large quantities of silicon nanowires, particularly those with a width of 100 nm or less. *Id.* at 1:17–19.

Sole independent claim 1, reproduced below, is illustrative of the subject matter on appeal (disputed limitation italicized).

> 1. A method of fabricating a silicon nanowire having a width of 100 nm or less comprising:
>
> depositing a metal film on a silicon-containing layer;
>
> *treating the metal film using a wet process to produce an interconnected metal network having gaps on the silicon-containing layer*;
>
> etching the silicon-containing layer with a metal-assisted etching process in which an etching solution and the interconnected metal network etch silicon of the silicon-containing layer, leaving unetched silicon of the silicon-containing layer in the gaps of the interconnected metal network to form a silicon nanowire having a width of 100 nm or less by controlling the width of the silicon nanowire through controlling the width of the gaps and the silicon nanowire having a length that is controlled by controlling the duration of etching.

Appeal Br. 13 (Claims Appendix).

ANALYSIS

We review the appealed rejections for error based upon the issues Appellant identifies, and in light of the arguments and evidence produced

thereon. *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) ("[I]t has long been the Board's practice to require an applicant to identify the alleged error in the examiner's rejections.")). After considering the argued claim in light of the case law presented in this Appeal and each of Appellant's arguments, we are not persuaded of reversible error in the appealed rejections.

The Examiner rejects claims 1, 4–22, and 31 as follows. Non-Final Act. 3–9.

Claims Rejected	35 U.S.C. §	Reference(s)/Basis
1, 4–7, 10–17, 19, 20, 31	103	Yu,[3] Lin[4]
21, 22	103	Yu, Lin, Banerjee[5]
7, 18	103	Yu, Lin, Xu[6]
8, 9	103	Yu, Lin, Liu[7]

Appellant separately argues the rejection of independent claim 1. Appeal Br. 3–9. In view of the lack of arguments directed to the remaining claims and the subsidiary rejections, claims 4–7, 10–16, 19, 20, 31 stand or fall with claim 1, and we will apply Appellant's arguments to the remaining rejections of claims 7–9, 18, 21, and 22. *See* 37 C.F.R. § 41.37(c)(1)(iv).

Rejection over Yu and Lin (Claims 1, 4–7, 10–17, 19, 20, 31)

Appellant contends that the Examiner erred in rejecting claim 1 over the combined teachings of Yu and Lin because neither Yu nor Lin alone or

[3] US 2015/0041937 A1, published Feb. 12, 2015.
[4] US 2013/0143407 A1, published June 6, 2013.
[5] US 2012/0326075 A1, published Dec. 27, 2012.
[6] US 2013/0309563 A1, published Nov. 21, 2013.
[7] US 2014/0335411 A1, published Nov. 13, 2014.

in combination discloses a "wet process" for producing an interconnected metal network having gaps on the silicon-containing layer as required by the claim. Appeal Br. 8–11. According to Appellant, the Specification discloses a "wet process" for removing metal and in contrast to a "separate and distinct metal-assisted etching process, which uses a wet 'etching solution,' [that] works with the metal to '**etch silicon**' under the metal." *Id.* at 8 (emphasis omitted) (citing Spec. 5:22).

Appellant argues that Yu uses a lithography process to form a pattern in the metal rather than an etching solution. *Id.* (citing Yu ¶ 35). Appellant distinguishes Lin's wet-etching solutions as (1) not similar to the "wet process" solution described in Appellant's Specification and (2) introduced only after a metal pattern has already been formed. *Id.* at 9 (citing Lin ¶¶ 6, 8; Spec. 4:7–5:9). Appellant asserts that Lin discloses exactly the same type of process as Yu in which metal is patterned using lithography or another non-wet process, followed by a wet-etching process, such as metal-assisted etching. *Id.* at 10.

The Examiner responds that Lin is cited to show the benefits that wet etching provides, namely its low cost. Ans. 3. The Examiner finds that wet etching of metal is notoriously well-known within the etching technology and such wet etching techniques have been performed on metal layers to form desired patterns. *Id.* The Examiner finds that Yu's disclosure that metal mask 212A in Figure 3A can be obtained "using various lithography techniques" suggests forming patterns using either dry or wet etching techniques. *Id.* (citing Yu ¶ 36). The Examiner further finds that Yu teaches applying a wet photoresist using a deposition method such as spin coating or spray coating, which are both considered a "wet process" because

fluids/solvents are involved to treat the metal film layer. *Id.* (citing Yu ¶ 36).

Appellant does not dispute the Examiner's finding (Ans. 3) that Yu's disclosure of a spin coating or spray coating to apply a wet photoresist to treat the metal film layer is a lithography technique and also a wet process. The cited record in this Appeal supports the Examiner's findings. Yu discloses forming an array pattern in the metal thin film using lithographic techniques that involve solvents and etching with a suitable etchant. Yu ¶¶ 36, 39. We are not persuaded that the Examiner erred in finding that Yu's "various lithography techniques" for forming a metal network having gaps include a "wet process" as claim 1 requires. Yu ¶ 36. The Examiner's reliance on Lin for teaching the cost benefit of wet etching over dry etching provides a reasoned basis for selecting a wet process from among the lithographic techniques taught by Yu. Ans. 3; Lin ¶ 6. Thus, the preponderance of the evidence in this appeal record supports the Examiner's conclusion that the claimed subject matter would have been obvious in view of Yu and Lin. Accordingly, we sustain the Examiner's rejection of claim 1 as well as the rejection of claims 4–7, 10–17, 19, 20, and 31 over the combination of Yu and Lin for essentially those reasons expressed in the Answer, including the Response to Argument section.

Rejections over Yu and Lin in combination with Banerjee, Xu, or Liu

Appellant requests reversal of all rejections under 35 U.S.C. § 103. Appeal Br. 11. Because we are not persuaded of error in the Examiner's rejection of sole independent claim 1 for the reasons discussed above, we likewise affirm the rejections of dependent claims 7–9, 18, 21, and 22 in the absence of arguments directed to the dependent claims.

For these reasons and those the Examiner provides, we uphold the Examiner's rejections of claims 1, 4–22, and 31 under 35 U.S.C. § 103 as obvious over the cited prior art references.

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).

CONCLUSION

In summary:

Claims Rejected	35 U.S.C. §	Reference(s)/Basis	Affirmed	Reversed
1, 4–7, 10–17, 19, 20, 31	103	Yu, Lin	1, 4–7, 10–17, 19, 20, 31	
21, 22	103	Yu, Lin, Banerjee	21, 22	
7, 18	103	Yu, Lin, Xu	7, 18	
8, 9	103	Yu, Lin, Liu	8, 9	
Overall Outcome			1, 4–22, 31	

AFFIRMED