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BEFORE THE PATENT TRIAL AND APPEAL BOARD

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*Ex parte* YUVAK SAADO

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Appeal 2019-002140  
Application 13/927,306  
Technology Center 2800

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Before MARK NAGUMO, KAREN M. HASTINGS, and  
JEFFREY W. ABRAHAM, *Administrative Patent Judges*.

ABRAHAM, *Administrative Patent Judge*.

DECISION ON APPEAL

Pursuant to 35 U.S.C. § 134(a), Appellant<sup>1</sup> appeals from the Examiner's decision to reject claims 1, 3, 4, 6–29, 31–40, and 43–48. We have jurisdiction under 35 U.S.C. § 6(b).

We REVERSE.

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<sup>1</sup> We use the word Appellant to refer to “applicant” as defined in 37 C.F.R. § 1.42(a). Appellant identifies the real party in interest as Micron Technology, Inc. Appeal Br. 2.

### CLAIMED SUBJECT MATTER

The claims are directed to photonic devices fabricated over semiconductor substrates. Spec. ¶ 1. Claim 1, reproduced below from the Claim Appendix (App. Br. 13), is illustrative of the claimed subject matter:

1. An integrated structure comprising:
  - a semiconductor substrate having a silicon material;
  - optical cladding formed in the substrate, the cladding comprising a plurality of spaced trenches formed in the silicon material, wherein the trenches are filled with oxide, and wherein the depth (d) of the trenches is less than the thickness of the silicon material;
  - and a waveguide comprising a core, the core being formed as a continuous slab of core material over the optical cladding and in direct contact with the silicon material and the oxide of the optical cladding.

### REJECTIONS ON APPEAL

On appeal, the Examiner maintains several rejections:

- A. Claims 1, 3, 4, 6, 7, 10–12, 19–21, and 25 under 35 U.S.C. § 103 as unpatentable over Block<sup>2</sup> in view of Barrios;<sup>3</sup>
- B. Claims 26–29, 31, 33–40, 43–46, and 48 under 35 U.S.C. § 103 as unpatentable over Block in view of Allan<sup>4</sup> and Barrios;
- C. Claims 8 and 9 under 35 U.S.C. § 103 as unpatentable over Block in view of Mouli<sup>5</sup> and Barrios;
- D. Claims 13–17 and 22–24 under 35 U.S.C. § 103 as unpatentable over Block in view of Allan and Barrios; and

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<sup>2</sup> Block et al., US 6,993,212 B2, issued Jan. 31, 2006.

<sup>3</sup> Barrios et al., US Pub. No. 2010/0142877 A1, published June 10, 2010.

<sup>4</sup> Allan et al., US 6,674,949 B2, issued Jan. 6, 2004.

<sup>5</sup> Mouli, US Pub. No. 2005/0281524 A1, published Dec. 22, 2005.

E. Claims 18, 32, and 47 under 35 U.S.C. § 103 as unpatentable over Block in view of Allan and Barrios, and further in view of Applicant-Admitted Prior Art.

Final Act. 3–28; Ans. 2.

## OPINION

Appellant presents arguments for independent claims 1, 26, and 38, but does not present any arguments for the dependent claims that depend from these claims. App. Br. 4–12. Therefore, we limit our discussion to independent claims 1, 26, and 38, which we select as representative under 37 C.F.R. § 41.37(c)(1)(iv). By this rule, claims 3, 4, and 6–25 stand or fall with claim 1, claims 27–29 and 31–37 stand or fall with claim 26, and claims 39, 40, and 43–48 stand or fall with claim 38.

### *Claim 1*

Claim 1 recites an integrated structure comprising “a semiconductor substrate having a silicon material,” and “an optical cladding formed in the substrate.” App. Br. 13. The optical cladding comprises “a plurality of spaced trenches formed in the silicon material,” wherein the depth of the trenches is less than the thickness of the silicon material. *Id.* Claim 1 also requires a waveguide comprising a core, the core being formed over the optical cladding. *Id.*

The Examiner contends that silicon substrate 101 and oxide lower cladding 140 of Block correspond to the semiconductor substrate recited in claim 1. Final Act. 4. The Examiner further contends that Block discloses an optical cladding formed in the substrate. *Id.* (citing Block, 3:53–59 and the “first cladding layer 140” in Figure 1 of Block). The Examiner acknowledges that Block does not disclose a cladding comprising a plurality

of spaced trenches in the silicon material, or that the depth of the trenches is less than the thickness of the silicon material. *Id.*

The Examiner indicates that Barrios discloses a waveguide made of multiple silicon layers, having cladding comprising spaced trenches in its top silicon layer, wherein the depth of the trenches is less than the thickness of the silicon material because the trenches are only in the top silicon layer. Final Act. 5. According to the Examiner, it would have been obvious to include the trenched cladding structure of Barrios as the cladding in Block's system. *Id.*

Appellant argues that Block and Barrios fail to disclose or suggest each feature of claim 1, including a cladding formed in the substrate having trenches with required thickness. App. Br. 7–8. With reference to Figure 1 of Block, Appellant contends that Block includes a cladding layer 140 formed *on* the substrate. *Id.* at 5. With reference to Figure 1 of Barrios, Appellant contends that Barrios discloses a modulator formed on a buried oxide layer which is supported by a silicon substrate. *Id.* at 6. Appellant also argues that the portion of Barrios having trenches is not the optical cladding formed in the substrate, as claim 1 requires, but is instead part of the waveguide of claim 1 that is formed over the optical cladding. *Id.* at 6–7.

The Examiner bears the initial burden of presenting a prima facie case of obviousness. *In re Oetiker*, 977 F.2d 1443, 1445 (Fed. Cir. 1992). “[R]ejections on obviousness grounds cannot be sustained by mere conclusory statements; instead, there must be some articulated reasoning with some rational underpinning to support the legal conclusion of

obviousness.” *In re Kahn*, 441 F.3d 977, 988 (Fed. Cir. 2006), quoted with approval in *KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 418 (2007).

After review of the respective positions provided by Appellant and the Examiner, we conclude that the preponderance of the evidence supports Appellant’s position that the Examiner has not established a prima facie case of obviousness.

The Examiner takes the position that the “substrate” in Block and Barrios is comprised of multiple layers. Final Act. 4–5. In particular, the Examiner contends that a substrate is not just the layer expressly identified as the “substrate” in the references, but includes additional layers on top of the substrate. *Id.* (referencing layers 101 and 140 in Fig. 1 of Block and layers 140, 110, and 115 in Fig. 1 of Barrios). The broadest reasonable interpretation of “substrate” as recited in claim 1 and consistent with the Specification, however, does not encompass the Examiner’s purported expansion of “substrate” in Block and Barrios to include other layers formed on the layer expressly identified as the substrate in those references.

“[D]uring examination proceedings, claims are given their broadest reasonable interpretation consistent with the specification.” *In re Translogic Tech., Inc.*, 504 F.3d 1249, 1256 (Fed. Cir. 2007) (quoting *In re Hyatt*, 211 F.3d 1367, 1372 (Fed. Cir. 2000)). *See also In re America Acad. of Sci. Tech Ctr.*, 367 F.3d 1359, 1364 (Fed. Cir. 2004) (The scope of the claims in patent applications is not determined solely on the basis of the claim language, but upon giving claims their broadest reasonable construction in light of the specification as it would be interpreted by one of ordinary skill in the art.). As stated in *In re Smith*,

The correct inquiry in giving a claim term its broadest reasonable interpretation in light of the specification is not whether the specification proscribes or precludes some broad reading of the claim term adopted by the examiner. And it is not simply an interpretation that is not inconsistent with the specification. It is an interpretation that corresponds with what and how the inventor describes his invention in the specification, *i.e.*, an interpretation that is “consistent with the specification.”

*In re Smith Int’l, Inc.*, 871 F.3d 1375, 1382–83 (Fed. Cir. 2017) (quoting *In re Morris*, 127 F.3d 1048, 1054 (Fed. Cir. 1997)).

The Specification, referring to Figure 1(A), describes a structure having a lower cladding formed in a substrate, and distinguishes, by name, the substrate from other layers formed over the substrate. Spec. ¶ 13.

Figure 1(A) of the present application is reproduced below.

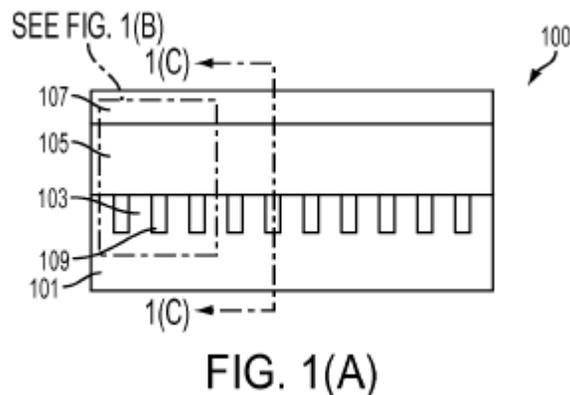


FIG. 1(A)

Figure 1(A) of the present application shows photonic device 100 formed on substrate 101, having waveguide core 105, and lower cladding formed by crystal 103 in substrate 101. Spec. ¶ 13. As shown in Figure 1(A), trenches 109 of photonic crystal 103 are formed in the single-layer substrate 101. *Id.* ¶ 14. By contrast, the waveguide core 105 is depicted as a separate layer over the cladding that is in the single-layer substrate 101, consistent with the language in claim 1,

In other places, the Specification consistently identifies the substrate as an independent layer, distinguished from other layers formed over it. For example, with reference to Figures 3(A) and 3(B), the Specification describes a process of forming the photonic device wherein mask 113 is formed over substrate 101. Figure 3(B) is reproduced below.

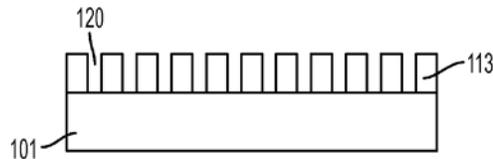


FIG. 3(B)

Figure 3(B) shows the patterned mask 113 formed over the single-layer substrate 101.

In light of the Specification and claims differentiating between elements formed in the substrate and over/on the substrate, the Examiner's reliance on elements formed on the substrate in Block and Barrios as being formed in the substrate, as recited in claim 1, is unfounded.

Figure 1 of Block is reproduced below.

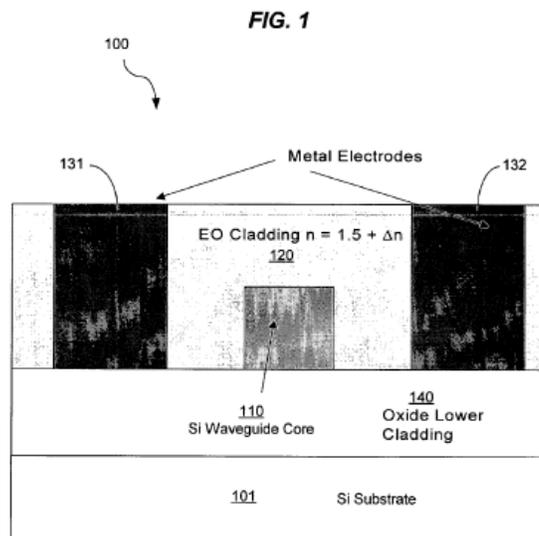


Figure 1 shows a cross sectional view of an integrated waveguide device, having oxide lower cladding 140 on substrate 101. Block’s description of Figure 1 confirms that “a first cladding layer 140 is formed on the substrate 101.” Block, 3:49–54, Fig. 1. Thus, we agree with Appellant that Block shows a cladding *on* the substrate, not *in* the substrate as the Examiner contends, and claim 1 requires. App. Br. 5; Final Act. 4.

The Examiner’s reliance on Barrios does not cure this deficiency. Figure 1 of Barrios is reproduced below:

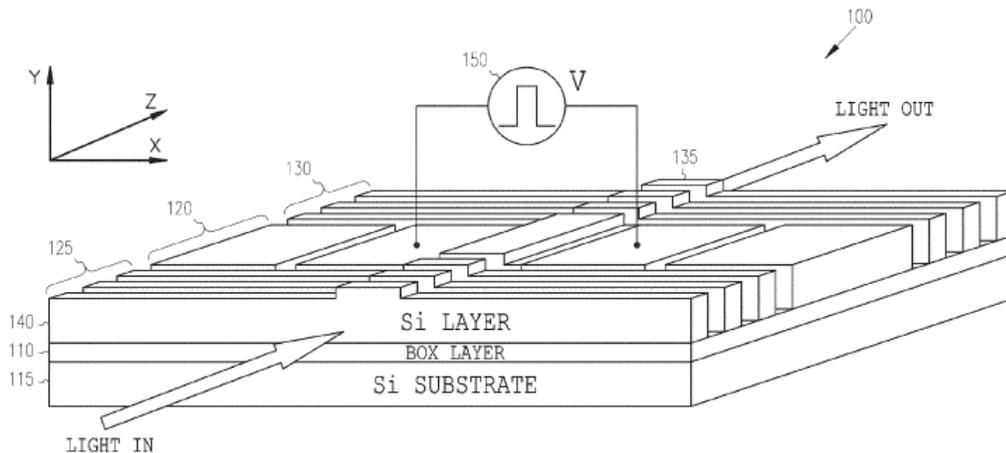


FIG. 1

Figure 1 shows an electro-optic modulator 100 having top silicon layer 140 on buried oxide (BOX) layer 110 and silicon substrate 115. Barrios, Fig. 1, ¶¶ 16–17. Although Barrios discloses a structure having trenches in silicon layer 140, that silicon layer is formed over a separate BOX layer (110), which is formed on another layer expressly identified as the “Si Substrate” (115). See Barrios ¶ 16 (stating that the modulator is formed on a buried oxide (BOX) layer 110 supported by a silicon substrate 115”). Thus, to the extent a person of ordinary skill in the art would consider layer 140 of

Barrios to be an optical cladding, a matter on which we make no finding, that layer is formed *on* a BOX layer, which is itself formed *on* a separately-identified substrate. As a result, layer 140 does not satisfy the requirement in claim 1 that the optical cladding is formed *in* the substrate.

Thus, the Examiner fails to show that Block and/or Barrios disclose or suggest each limitation of claim 1, namely a cladding formed in the substrate. Moreover, the Examiner's discussion of reasons why a person of ordinary skill in the art would have combined the teachings of Block and Barrios does not cure this deficiency. Final Act. 5–6; Ans. 2–3. Even if a person of ordinary skill in the art would have been motivated to use the “cladding” of Barrios in place of any cladding layer of Block, it is not clear how that modified Block structure would provide an optical cladding layer formed in the substrate, as claim 1 requires. *See* Final Act. 5–6.

Because the Examiner fails to demonstrate sufficiently that Block and Barrios disclose or suggest each limitation of claim 1, we reverse the Examiner's rejection of claim 1, and claims 3, 4, and 6–25, which depend therefrom.

#### *Claim 26*

Similar to claim 1, claim 26 is drawn to an integrated structure, and recites “a lower cladding formed as a photonic crystal *within* a silicon substrate,” having trenches of a depth less than the thickness of the substrate. App. Br. 16 (emphasis added). Claim 26 further requires a core formed on the lower cladding. *Id.*

As with the rejection of claim 1, the Examiner relies on the combination of Block and Barrios as disclosing a lower cladding comprising a plurality of trenches formed within the silicon substrate. Final Act. 10–12.

The Examiner relies on Allan for its disclosure of an active photonic crystal waveguide. *Id.* at 11.

Appellant's arguments regarding claim 26 are similar to those presented in response to the rejection of claim 1. App. Br. 8–10. For example, Appellant argues that the combined teachings of Block, Barrios, and Allen fail to disclose every feature of claim 26, including, *inter alia*, a lower cladding formed as a photonic crystal within a silicon substrate, having the trenches recited in claim 26. *Id.* at 9.

In view of the similar arguments made by the Examiner and Appellant, we reverse the rejection of claim 26 for the same reasons discussed above regarding claim 1. In particular, the Examiner fails to demonstrate adequately that Block and Barrios disclose a lower cladding formed *within* a silicon substrate, and a core formed on the lower cladding, as claim 26 requires. Nor does the Examiner demonstrate adequately that Allan cures this deficiency.

Because the Examiner fails to prove that Block, Barrios, and Allan disclose or suggest each limitation of claim 26, we reverse the Examiner's rejection of claim 26, and claims 27–29 and 31–37, which depend therefrom.

#### *Claim 38*

Claim 38 recites a method for forming an integrated structure, comprising “forming a photonic crystal on a silicon substrate wherein the photonic crystal is formed by positioning spaced trenches within a silicon layer, the depth (d) of the spaced trenches is less than the thickness of the substrate.” App. Br. 17.

The Examiner contends that Allen and Block together disclose forming a photonic crystal on a silicon substrate, and that Barrios discloses

that the depth of the trenches is less than the thickness of the substrate, relying on an analysis similar to the analysis provided for claims 1 and 26. Final Act. 17 (“In achieving the structure as set forth in claims 1 and 26, above, Block in view of Allan and Barrios as set forth above would achieve the method of claim 38.”). Appellant disputes that Allan, Block, and Barrios disclose these features, and argues that a person of ordinary skill in the art would not be motivated to modify the teachings of the references to arrive at a structure having these features. App. Br. 11.

Unlike claim 26, Claim 38 recites a photonic crystal formed *on* a silicon substrate, not *within* the substrate. Similar to claim 26, however, claim 38 still requires that the depth of the trenches of the photonic crystal is less than the thickness of the substrate. We agree that the combined disclosure of Block, Allen, and Barrios discloses trenches in a layer formed on a substrate. The Examiner, however, does not direct us to evidence sufficient to determine whether the depth of the trenches in Barrios is less than the thickness of the substrate. The Examiner relies on Figures 1 and 2 of Berrios (Final Act. 17), which show trenches in layer 140, situated above the Si Substrate layer 115. The figures do not contain any quantitative values from which a person of ordinary skill in the art could determine relative depths of the trenches compared to the thickness of the substrate.

Nor are we persuaded by the Examiner’s reasoning (provided with regard to the rejection of claim 1) that the depth of the trenches in Barrios is less than the thickness of the silicon material of the substrate because the trenches are only in the top silicon layer 140. Final Act. 5. This argument is based on the Examiner’s position that the silicon layer 140 is in the

substrate, not on the substrate. For the reasons discussed above, however, this position is unfounded.

As a result, we find the Examiner has failed to demonstrate adequately that the combined teachings of Block, Barrios, and Allan disclose or suggest “forming a photonic crystal on a silicon substrate wherein the photonic crystal is formed by positioning spaced trenches within a silicon layer, the depth (d) of the spaced trenches is less than the thickness of the substrate.” App. Br. 17. Moreover, the Examiner’s discussion of reasons why a person of ordinary skill in the art would have combined the teachings of Block, Barrios, and Allan does not cure this deficiency. Final Act. 5–6, 11; Ans. 2–6.

Because the Examiner failed to prove that Block, Barrios, and Allan disclose or suggest each limitation of claim 38, we reverse the Examiner’s rejection of claim 38, and claims 39, 40, and 43–48, which depend therefrom.

### CONCLUSION

The Examiner’s rejections are reversed.

### DECISION SUMMARY

In summary:

<b>Claims Rejected</b>	<b>35 U.S.C. §</b>	<b>Reference(s)/Basis</b>	<b>Affirmed</b>	<b>Reversed</b>
1, 3, 4, 6, 7, 10–12, 19–21, 25	103	Block, Barrios		1, 3, 4, 6, 7, 10–12, 19–21, 25
26–29, 31, 33–40, 43–46, 48	103	Block, Barrios, Allan		26–29, 31, 33–40, 43–46, 48

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8, 9	103	Block, Mouli, Barrios		8, 9
13-17, 22- 24	103	Block, Allan, Barrios		13-17, 22- 24
18, 32, 47	103	Block, Allan, Barrios, AAPA		18, 32, 47
<b>Overall Outcome</b>				1, 3, 4, 6- 29, 31-40, 43-48

REVERSED