United States Court of Appeals for the Federal Circuit

HD SILICON SOLUTIONS LLC,
Appellant

v.

MICROCHIP TECHNOLOGY INC.,
Appellee

2023-1397

Appeal from the United States Patent and Trademark Office, Patent Trial and Appeal Board in No. IPR2021-00752.

Decided: February 6, 2025

SARAH S. BROOKS, Venable LLP, Los Angeles, CA, argued for appellant. Also represented by JUSTIN J. OLIVER, Washington, DC.

BRETT M. SCHUMAN, Goodwin Procter LLP, San Francisco, CA, argued for appellee. Also represented by RACHEL M. WALSH; SANJEET DUTTA, Redwood City, CA; ROHINIYURIE TASHIMA, Washington, DC.

Before LOURIE, STOLL, and CUNNINGHAM, *Circuit Judges*.

LOURIE, *Circuit Judge*.

HD Silicon Solutions LLC ("HDSS") appeals from a final written decision of the United States Patent and Trademark Office Patent Trial and Appeal Board ("the Board") holding claims 1–7 and 9–17 of U.S. Patent 6,774,033 ("the '033 patent") unpatentable as obvious. *Microchip Tech. Inc. v. HD Silicon Sols. LLC*, No. IPR2021-00752, 2022 WL 16748547 (P.T.A.B. Nov. 7, 2022) ("*Decision*"). For the following reasons, we affirm.

BACKGROUND

The '033 patent is directed to a local interconnect layer in an integrated circuit. '033 patent, col. 1 ll. 49–50. To connect transistors within an integrated circuit, a local interconnect layer "provide[s] relatively short electrical paths between" the transistors. *Id.* col. 1 ll. 31–32. The challenged claims include independent claims 1 and 15. Claim 1 recites:

> 1. A method of forming a local interconnect layer in an integrated circuit, the method comprising:
>
> > depositing a first film over an oxide layer, the first film comprising titanium nitride; and
> >
> > depositing a second film over the first film, *the second film comprising tungsten*, the first film and the second film forming a metal stack of the local interconnect layer.

Id. col. 5 l. 55–col. 6 l. 4 (emphasis added). The dependent claims add limitations specifying the technique used to deposit the films, the thickness of one or both of the films, and the type of etchant used to etch the films. *See generally id.* col. 6 ll. 5–56.

Microchip Technology Inc. ("Microchip") petitioned for *inter partes* review ("IPR"), arguing that all claims of the '033 patent would have been obvious over U.S. Patent

5,847,463 (“Trivedi”). Trivedi is directed to a method of forming a local interconnect structure that has “tungsten silicide and titanium nitride layers, or has a tungsten layer covered on opposite sides thereof with titanium nitride.” Trivedi, col. 1 ll. 10–12.

At the Board, the parties disputed the construction of the term “comprising tungsten,” found in all challenged claims. Based on the text of the claims, the specification, and extrinsic evidence, the Board construed “comprising tungsten” to mean any form of tungsten, including both elemental tungsten and tungsten compounds. *Decision* at *3–6. The Board then held that Microchip had met its burden to show that all claims of the ’033 patent, except claim 8, are unpatentable, based on either Trivedi alone or Trivedi in combination with one or more secondary references. *Id.* at *6–32.

HDSS timely appealed. We have jurisdiction under 28 U.S.C. § 1295(a)(4)(A).

DISCUSSION

HDSS presents two main arguments on appeal. The principal argument is that the Board improperly construed the phrase “comprising tungsten.” In the alternative, HDSS separately challenges the Board’s motivation to combine findings as to certain dependent claims.

Although we conclude that the Board’s claim construction was erroneous, we determine that that error was harmless. We further reject HDSS’s challenges to the Board’s motivation to combine findings.

I

We interpret claim terms from the perspective of a person of ordinary skill in the art at the time of the invention, who is “deemed to read the claim term not only in the context of the particular claim in which the disputed term appears, but in the context of the entire patent, including the

specification." *Phillips v. AWH Corp.*, 415 F.3d 1303, 1313 (Fed. Cir. 2005) (en banc). Evidence extrinsic to the patent may also be useful in construing claim terms, but is generally viewed as "less reliable than the patent" itself. *Id.* at 1318.

"Claim construction is ultimately a question of law, decided de novo on review . . . [b]ut we review any underlying fact findings about extrinsic evidence . . . for substantial-evidence support when the appeal comes from the Board." *Intel Corp. v. Qualcomm Inc.*, 21 F.4th 801, 808 (Fed. Cir. 2021).

The '033 patent claims use precise language, *i.e.*, the recitation of another element, when referencing materials in their compound form. Specifically, claim 1 recites that the first film of the local interconnect "compris[es] titanium *nitride*." '033 patent, col. 5 l. 58 (emphasis added). Compare that to how claim 1 recites the composition of the second film, that it "compris[es] tungsten," without the presence of another element. *Id.* col. 6 l. 2. This suggests that the '033 patent uses explicit language to refer to a compound when a compound is intended, and when no such language is included, only the elemental form is intended. A claim to "tungsten," on its own, therefore refers to elemental tungsten.

Furthermore, the specification exclusively refers to tungsten as a singular component, *i.e.*, as an element. *E.g.*, *id.* col. 3 ll. 8–10 ("Additionally, titanium nitride may serve as a barrier and adhesion layer for a subsequently deposited tungsten film."). And when referencing the properties of tungsten that make it a desirable material for use in a local interconnect, the specification refers to properties unique to tungsten itself—not compounds of tungsten—such as low resistivity and chemical stability. *Id.* col. 3 ll. 41–42 ("Tungsten also has a relatively low resistivity compared to titanium nitride."); *id.* col. 3 ll. 47–48 ("Relatively speaking, tungsten is also a chemically stable

material."). Indeed, at oral argument, Microchip's counsel conceded that when "the specification refers to a layer of tungsten . . . that is referencing elemental tungsten." *See* Oral Arg. at 15:50–16:03, *available at* https://oralarguments.cafc.uscourts.gov/default.aspx?fl=23-1397_11062024.mp3. Not once is a tungsten compound mentioned in the specification, let alone in the prosecution history.

Consistent with this understanding, the '033 patent uses an open-ended modifier when referring to materials that include both compounds and elements. Dependent claim 12 refers to a "chlorine-*based* etchant," '033 patent col. 6 ll. 36 (emphasis added), which the specification defines as including both chlorine compounds and elemental chlorine, *id.* col. 4 ll. 13–16. ("In one embodiment, a chlorine-based etchant, such as boron trichloride (BCl_3) or chlorine (Cl_2), is employed to etch a film 103 of titanium nitride stopping on oxide layer 102."). *See also id.* col. 6 ll. 33 ("fluorine-based etchants"). That further demonstrates that when the '033 patent references "tungsten" on its own, it is referring to tungsten in its elemental form.

The Board's core reasoning in coming to its construction was based on one sentence in the '033 patent: "The first film may comprise titanium nitride, while the second film may comprise tungsten, for example." *Id.* col. 1 ll. 53–54; *see Decision* at *5. According to the Board, the phrase, "for example," means that elemental tungsten is just "one exemplary embodiment" of a "second film comprising tungsten," and therefore the limitation cannot be so narrowed. *Decision* at *5.

We agree with the Board that this sentence refers to tungsten as an exemplary embodiment of a "second film comprising tungsten." Nevertheless, the Board's reasoning is flawed because it assumes that there are only two forms of tungsten—purely elemental tungsten and tungsten compounds. But that is not the case. As explained by HDSS's expert, "[b]y using the terminology of comprising tungsten,

[the claim] allows for the possibility of unintentional impurities that might be incorporated during the deposition process." J.A. 3069 ¶ 48; *see also* Oral Arg. at 2:04–2:06, 4:08–4:13 (counsel for HDSS explaining that the phrase "comprising tungsten" includes elemental tungsten attached to other "minute particles" or "minute elements."). The incorporation of minute materials with elemental tungsten does not constitute a tungsten compound. Thus, when read in accord with the understanding that elemental tungsten may include additional minute materials, yet still not be a compound, the description of elemental tungsten as an "example" is not inconsistent with the '033 patent's disclosures indicating that the patent requires elemental tungsten.

The Board also relied on European Patent Application Publication 0463373 ("Gunturi") in coming to its construction. *Decision* at *6. Gunturi recites "forming [a] local interconnect structure using a material comprising tungsten," Gunturi col. 4 ll. 28–29, and discloses that such material may be "a thin layer of tungsten silicide," a tungsten compound. *Id.* col. 3 l. 39. Accordingly, the Board reasoned that Gunturi "teaches that the phrase 'comprising tungsten' includes" tungsten compounds. *Decision* at *6.

While the Board's interpretation of Gunturi is certainly reasonable, Gunturi is insufficient to support the Board's construction because it conflicts with the specification, claims, and prosecution history of the '033 patent, which indicate that "comprising tungsten" requires elemental tungsten. *See Bell Atl. Network Servs., Inc. v. Covad Commc'ns Grp.*, Inc., 262 F.3d 1258, 1269 (Fed. Cir. 2001) ("[E]xtrinsic evidence may be used only to assist in the proper understanding of the disputed limitation; it may not be used to vary, contradict, expand, or limit the claim language from how it is defined, even by implication, in the specification or file history.").

For the foregoing reasons, the Board's claim construction was erroneous. The term "comprising tungsten," as recited in the challenged claims, requires elemental tungsten.

II

A

We next consider how the Board's obviousness determinations are impacted by our rejection of the Board's claim construction. Obviousness is a question of law based on underlying findings of fact. *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 427 (2007). We review the Board's legal conclusion on obviousness *de novo* and its findings of fact for substantial evidence. *HTC Corp. v. Cellular Commc'ns Equip., LLC*, 877 F.3d 1361, 1369 (Fed. Cir. 2017). What a reference teaches and the presence or absence of a motivation to combine references are questions of fact. *PAR Pharm., Inc. v. TWI Pharms., Inc.*, 773 F.3d 1186, 1196–97 (Fed. Cir. 2014).

HDSS asserts that reversal or vacatur of the Board's obviousness findings is required because the findings were dependent on the Board's incorrect construction of "comprising tungsten," which is recited in each of the challenged claims. HDSS Br. 28. Microchip argues the contrary, that even under an elemental tungsten-requiring construction, the Board's findings should be affirmed because the main prior art reference, Trivedi, discloses both elemental tungsten and tungsten-silicide layers, and the Board found that both layers would have rendered the "second film comprising tungsten" limitation obvious. Oral Arg. at 22:10–22:52 (Microchip counsel asserting that HDSS's claim construction argument does not "matter" because Trivedi also "teaches [elemental] tungsten as the second film and the [Board] relied on that" disclosure).

We agree with Microchip. The Board found that Trivedi discloses both a tungsten-silicide *and* an elemental

tungsten layer, and either disclosure would render the "second film comprising tungsten" limitation of claim 1 obvious: "Trivedi itself teaches that either tungsten silicide or elemental tungsten may be used to form the [second] local interconnect layer" of claim 1. *Decision* at *9. That finding is consistent with what Trivedi discloses and is therefore supported by substantial evidence. Trivedi col. 1 ll. 10–12. ("[T]he local interconnect has tungsten silicide and titanium nitride layers, *or has a tungsten layer covered on opposite sides thereof with titanium nitride*." (emphasis added)). Further recall that the dependent claims only add limitations with respect to the technique used to deposit the films, the thickness of one or both of the films, and the type of etchant used to etch the films. *See generally* '033 patent, col. 6 ll. 5–56. The Board's obviousness findings are equally supported regardless whether Trivedi's elemental tungsten or tungsten-silicide layers are used to render claim 1 obvious. HDSS presents no argument in response.

Therefore, although the Board erred in construing "comprising tungsten," that error was harmless.

B

Finally, we address HDSS's arguments challenging the Board's findings of obviousness with respect to certain dependent claims.

HDSS contends that some of the Board's obviousness findings were not supported by substantial evidence because the Board: (1) misinterpreted Trivedi's disfavor of certain deposition and etching techniques disclosed by the other references, and (2) did not explain why a person of ordinary skill in the art would combine Trivedi and the other references to meet certain dependent claims' specific thicknesses. We disagree on both counts.

The Board thoroughly considered HDSS's arguments as to Trivedi's purported disfavor of certain deposition and etching techniques and reasonably rejected them. *See, e.g.*,

Decision at *17 ("While Trivedi may have expressed a preference for [a non-sputtering process for the tungsten layer] . . . Trivedi also teaches [a] [sputtering] process to form layers in the local interconnect."). Moreover, the Board provided thorough and well-reasoned explanations, relying on the testimony of Microchip's expert, for why a person of ordinary skill in the art would be motivated to combine Trivedi with one or more of the other references to arrive at the specific thicknesses of the challenged dependent claims. *See, e.g.*, *Decision* at *21 (a person of ordinary skill in the art would be motivated to "apply [another reference's] thicknesses to Trivedi's local interconnect" because such a combination was a "predictabl[e]" combination of known features). At bottom, HDSS asks us to reweigh the evidence, which we decline to do. *Roku, Inc. v. Universal Elecs., Inc.*, 63 F.4th 1319, 1326 (Fed. Cir. 2023) ("An appellate court does not and should not reweigh evidence or make factual findings." (cleaned up)).

CONCLUSION

We have considered HDSS's remaining arguments and find them unpersuasive. For the reasons provided, we affirm.

AFFIRMED