

UNITED STATES DISTRICT COURT
NORTHERN DISTRICT OF CALIFORNIA

ALPHA AND OMEGA
SEMICONDUCTOR LIMITED, et al.,

Plaintiffs,

v.

FORCE MOS TECHNOLOGY CO., LTD.,

Defendant.

Case No. 22-cv-05448-PCP

CLAIM CONSTRUCTION ORDER

This is a patent case involving metal oxide semiconductor field effect transistors, or MOSFETs. Plaintiffs Alpha and Omega Semiconductor Limited and Alpha and Omega Semiconductor Inc. (AOS) and defendant Force MOS Technology Co., Ltd. each allege infringement of several patents. Across the seven patents at issue, the parties ask for construction of ten terms. The Court construes these terms as set forth below.

I. Background

Semiconductors, as their name suggests, are materials that have a conductivity somewhere between conductors and insulators. One such material is silicon. In pure form, silicon atoms form a crystal lattice structure. Introducing impurities into this structure modifies its conductivity—a process called “doping.” Replacing some of the silicon atoms in the lattice with “electron donor” elements like phosphorus or arsenic (which have five electrons in their outer shell where only four are needed to form the four covalent bonds with the adjacent atoms in the crystal structure) is known as “n-type” doping, a reference to the negative charge of the extra electron. *See* Josef Lutz et al., *Semiconductor Power Devices* 35 (2d ed. 2018), Dkt. No. 74-13, at 16. Similarly, “p-type” doping uses “electron acceptor” elements like boron or gallium (which have one less electron than needed for the four covalent bonds). *Id.* A “pn-junction” is formed at the seam between a p-type

and an n-type doped region. *Id.* at 101, Dkt. No. 74-13, at 26. These junctions are “rectifying”: they conduct current when voltage is applied in a “forward” direction, but the conductivity in the other direction, the “blocking” direction, is minimal. *Id.* This property means that differently doped semiconductor materials forming such junctions can be arranged, along with conductor and insulator materials, to create devices like MOSFETs that can switch or amplify electrical signals.

Power MOSFETs are one such device. They are designed to handle significant current and voltage. Like other transistors, power MOSFETs have three electrical leads or terminals: a source, a drain, and a gate. Applying a voltage to the gate terminal controls the conductivity between the source and drain terminals. In a trench power MOSFET, current flows vertically from the source on the top layer of a silicon chip to the drain on the bottom, controlled by gates located in “trenches” within the chip. Today, trench power MOSFETs are ubiquitous. They appear in a wide range of electronics from computers to cars. *See, e.g.,* Richard K. Williams et al., *The Trench Power MOSFET: Part I—History, Technology, and Prospects*, 64 IEEE Transactions on Electron Devices 674 (2017), Dkt. No. 74-17, at 2. The patents asserted in this case pertain to various inventions to make power MOSFETs better, smaller, and cheaper.

A. Force MOS Patents

Force MOS asserts three patents, from which AOS seeks construction of five terms.

The first is U.S. Patent No. 7,629,634. This patent involves a trench MOSFET where the source contacts are trenched in addition to the gates. In this design, metal contact plugs extend into source contact trenches within the semiconductor material. The patent describes how in the prior art, source contact trenches have a p^+ -type contact layer (p^+ represents a particular level of p-type doping) at the bottom of the trench to provide ohmic contact between the metal contact plug and the base of the trench. In addition to the contact layer at the bottom of the trench, the '634 Patent also adds a p^* -type contact layer at the side walls of the contact trench (p^* represents slightly less p-type doping than p^+). This addition aims to improve the performance of the chip.

The second patent Force MOS asserts is U.S. Patent No. 7,847,346. This patent proposes a new source contact trench structure to allow for greater cell density and lower resistance, as well as lower fabrication costs.

The third patent Force MOS asserts is U.S. Patent No. 7,646,058. This patent seeks to improve the heat dissipation of trench MOSFETs—a challenge as chip sizes shrink. In particular, this patent proposes a wider contact area between the front metal atop the chip and the wires that facilitate external connection, as well as using metals with better thermal conductivity than those used in the prior art.

B. AOS Patents

AOS asserts four patents, from which Force MOS seeks construction of five terms.

The first is U.S. Patent No. 8,067,304. To allow external connections, MOSFET chips must be bonded to metal wires. As the '304 Patent's specification explains, copper wire is cheaper than gold or aluminum—the traditional choices. But copper is also a harder material, so bonding copper wire to the top surface of a semiconductor power chip requires a thicker metal layer on top of the chip (3–6 microns as opposed to 1–3). Applying that thicker metal layer creates challenges. The chip fabrication process begins with a semiconductor wafer that has built-in “alignment marks,” which are indentations at specified locations used to line up a mask at a later step in the fabrication process. Adding a layer of metal on top of the wafer can degrade the sharpness of the alignment marks, which in turn makes alignment for the masking process less precise. This problem becomes more pronounced the thicker the metal layer is. The '034 Patent proposes a new approach: first applying a thin layer of “hot” metal (400° C), which has good “step coverage” and better fills voids in the surface of the wafer, and then applying a thicker layer of “cold” metal (300° ± 50° C), which better preserves the alignment marks even when the overall metal layer is thick enough to allow bonding of copper wire.

The second and third patents AOS asserts are U.S. Patent Nos. 7,511,361 and 7,781,265. The two are related: The '361 Patent is directed to a semiconductor package, while the '265 Patent is directed to the method of making that package. Semiconductor devices generally need to be packaged because of their fragility. But they also need to provide an external interface for electrical connections. One approach is with “lead” wires that protrude from the package. In a flat non-leaded package, though, there are connection pads that are flush with the surface of the package instead of lead wires that protrude. Inside of the package, wires conduct the

semiconductor chip to the external pads. The source terminals on the chip are connected to a “source bonding area,” and the gate terminals are connected to a “gate bonding area.” The problem the patents identify with traditional packages is that they have narrow source and gate bonding areas, which means that relatively few wires can be connected to them. This, in turn, increases the overall electrical resistance of the entire package. The ’361 and ’265 Patents aim to reduce the electrical resistance and inductance of the package and improve its thermal dissipation. They do this by increasing the surface area of the source and gate bonding areas to allow more (and bigger) wires to be connected.

The fourth patent AOS asserts is U.S. Patent No. 8,928,079. This patent aims to address some of the inherent tradeoffs between certain characteristics of MOSFETs. One characteristic is the MOSFET’s “on-resistance,” which is the resistance between the source and drain terminals when a voltage is applied to the gate terminal. This is typically proportional to the length of the channel between the source drain terminals and inversely proportional to the concentration of cells in the chip. Another is the gate capacitance, which is proportional to both channel length and cell concentration. Cell concentration is limited by the state of manufacturing technology. The “punch-through phenomenon” (which occurs when the depletion region between the source and drain expands so far that it reaches the source junction) means that channels cannot be too short. The ’079 Patent aims to work around these constraints and reduce the on-resistance of the device. One of the ways it does this is by including a thin layer of body region below the source contact trench. This layer thus separates the source contact trench and the drain, and creates a low injection diode which ensures that the layer is almost depleted in reverse bias but not depleted in forward bias.

II. Legal Standards

Section 112 of the Patent Act directs that a patent specification “shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains ... to make and use the same,” and requires that the specification “conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the inventor or a joint inventor regards as the invention.” 35 U.S.C. § 112.

“It is a bedrock principle of patent law that the claims of a patent define the invention to which the patentee is entitled the right to exclude.” *Phillips v. AWH Corp.*, 415 F.3d 1303, 1312 (Fed. Cir. 2005) (cleaned up). Claim terms “are generally given their ordinary and customary meaning,” which is “the meaning that the term would have to a person of ordinary skill in the art in question at the time of the invention.” *Id.* at 1312–13. This “person of ordinary skill in the art 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.” *Id.* at 1313.

Courts construe the meaning of language used in patent claims as a matter of law. *Markman v. Westview Instruments, Inc.*, 52 F.3d 967, 979 (Fed. Cir. 1995). “Because the meaning of a claim term as understood by persons of skill in the art is often not immediately apparent, and because patentees frequently use terms idiosyncratically, the court looks to those sources available to the public that show what a person of skill in the art would have understood disputed claim language to mean. Those sources include the words of the claims themselves, the remainder of the specification, the prosecution history, and extrinsic evidence concerning relevant scientific principles, the meaning of technical terms, and the state of the art.” *Phillips*, 415 F.3d at 1314 (cleaned up). In addition to the words, structure, and context of the claims themselves, the patent specification is “highly relevant” and is “the single best guide to the meaning of a disputed term.” *Vitronics Corp. v. Conceptronic, Inc.*, 90 F.3d 1576, 1582 (Fed. Cir. 1996). Courts may also look to the patent’s prosecution history, especially to “exclude any interpretation that was disclaimed.” *Chimie v. PPG Indus., Inc.*, 402 F.3d 1371, 1384 (Fed. Cir. 2005). Finally, courts have discretion to consider extrinsic evidence like dictionaries, treatises, and expert testimony. *Phillips*, 415 F.3d at 1317. But extrinsic evidence is “less significant” and “less reliable” than the intrinsic record and should only be “considered in the context of the intrinsic evidence.” *Id.* at 1317–19.

Under Section 112, “a patent is invalid for indefiniteness if its claims, read in light of the specification delineating the patent, and the prosecution history, fail to inform, with reasonable certainty, those skilled in the art about the scope of the invention.” *Nautilus, Inc. v. Biosig Instruments, Inc.*, 572 U.S. 898, 901 (2014). Determining whether a claim is indefinite requires “a delicate balance.” *Id.* at 909 (cleaned up). This inquiry focuses on whole claims rather than

particular terms. *Cox Commc 'ns, Inc. v. Sprint Commc 'n Co. LP*, 838 F.3d 1224, 1231 (Fed. Cir. 2016). And it must account for “the inherent limitations of language” and the fact that “patents are not addressed to lawyers, or even to the public generally, but rather to those skilled in the relevant art.” *Nautilus*, 572 U.S. at 909. Still, “a patent must be precise enough to afford clear notice of what is claimed, thereby apprising the public of what is still open to them.” *Id.* (cleaned up). “Indefiniteness must be proven by clear and convincing evidence.” *Sonix Tech. Co. v. Publ'ns Int'l, Ltd.*, 844 F.3d 1370, 1377 (Fed. Cir. 2017).

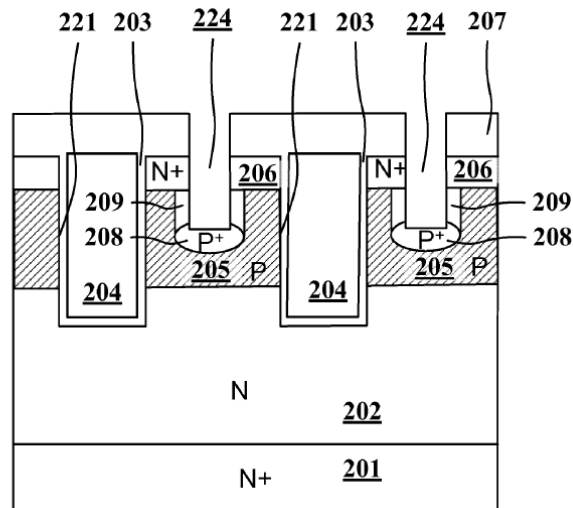
III. Construction of Disputed Terms

The parties propose ten terms for construction pursuant to the local patent rules. The first five are proposed by AOS and the remainder by Force MOS. The terms are construed as follows.

Term 1 (Force MOS '634 Patent, Claim 1)

Claim Language	“sidewalls of said trenches in said base layer are covered by the lateral contact layer”
AOS Proposal	“entire sidewalls of source contact trenches are covered by the lateral contact layer”
Force MOS Proposal	plain and ordinary meaning / no express construction required
Court's Construction	“portions of the sidewalls of said trenches that are within said base layer are entirely covered by the lateral contact layer”

The first disputed term appears in the first claim of Force MOS's '634 patent. A diagram is helpful. Figure 2E from the '634 Patent shows some of the relevant regions:



In this claim, “said trenches” refers to the “source contact trenches,” which are labeled 224. The claim explains how the source contract trenches extend through three layers: The trenches start from the interlayer oxide film on top then extend through the source layer into (but not completely through) the base layer. From top down in the diagram, these three layers are labeled 207 (interlayer oxide film), 206 (source layer), and 205 (base layer). The “lateral contact layer” is labeled 209 and the “base contact layer” is labeled 208.

The parties’ dispute essentially boils down to what it means for the lateral contact layer to “cover” the sidewalls of the source contact trenches in the base layer. AOS contends that “covered” means that the base layer portion of the trench is *entirely* covered. AOS’s proposed language is admittedly clunky: by eliminating “in said base layer” from the actual claim language, AOS’s proposal could suggest that AOS thinks the entire interior vertical portion of the source trench—extending through all three layers—must be “entirely covered” by the lateral contact layer. But AOS clarified in its brief that it only contends that the portion of the sidewall extending into the base layer, and not any other portions of the sidewall, must be entirely covered. Force MOS counters that “covered” does not mean that the lateral contact layer must entirely cover even the base layer portion of the sidewall.

A construction requiring that the lateral contact layer cover all three layers of the sidewall would clearly be incorrect. The claim language explicitly specifies that only the “sidewalls ... in

said base layer” must be “covered by the lateral contact layer.” So the question is *how much* of the base layer portion of the sidewalls must be covered.

Force MOS argues that reading the claim to require the lateral contact layer to fully cover the base layer portion of the sidewall would contradict the patent’s specification. Specifically, the specification reads:

[A]n implantation procedure ... and an activation by heat treatment are carried out to form a P-type base contact layer (208) *under the bottom* of the source contact trench (224). ... [A]nother implantation procedure ... and another activation by heat treatment are carried out to form a P*-type lateral contact layer (209) *at the sidewall* of the source contact trench (224).

’634 Patent, col. 3 (emphasis added). Claim 1 then states that “the sidewalls of said trenches in said base layer *are covered* by the lateral contact layer” and “the bottom base of said trenches in said base layer *are covered* by the base contact layer.” *Id.* col 6 (emphasis added). According to Force MOS, because the language “*at a sidewall*” does not require any particular degree of coverage, a construction of “covered” as meaning “entirely covered” would contradict the specification. The Court is not convinced. Even assuming that “*at a sidewall*” does not specify a degree of coverage, it does not follow that a claim term that *does* specify a degree of coverage would be inconsistent. Here, the prepositional phrases from the specification (“*under the bottom*” and “*at the sidewall*”) are best read as describing the location, rather than the degree of coverage, of the base and lateral contact layers, and leaving the question of degree of coverage open.

The prosecution history supports a conclusion that the “covered by” language must at least mean something different (if not necessarily narrower) than the “*at a sidewall*” language. The version of claim 1 originally filed stated that “each of the source contract trenches has a lateral contact layer *at a sidewall* ... of source contact trench thereof.” *See* Dkt. No. 80-3, at 15–16 (emphasis added). In other words, claim 1 originally used the same language that is still used in the specification to discuss the lateral contact layer. But the examiner amended this language, which the inventor authorized in a series of email and telephone interviews. The amendment modified the claim to its present form: specifying that the “the sidewalls of said trenches in said base layer are covered by the lateral contact layer.” *See* Dkt. No. 80-5, at 3–4. This amendment

made two notable changes. First, it clarified *where* at the sidewall the lateral contact was located: the portion of the sidewall “in said base layer.” Second, it specified that this portion of the sidewall is “covered by” the lateral contact layer.

It is clear that the patent examiner understood the amended language to mean that the lateral contact layer must entirely cover the base layer portion of the sidewall. The examiner’s reasons for allowance stated that “Claim 1 limits the trenched MOSFET to having a trench in which the base and entire sidewall are covered with the lateral contact layer.” Dkt. No. 80-5, at 4. The reasons for allowance alone do not resolve this dispute, however, because “unilateral statements by an examiner do not give rise to a clear disavowal of claim scope by an applicant.” *Salazar v. Procter & Gamble Co.*, 414 F.3d 1342, 1347 (Fed. Cir. 2005). Still, this does not mean that the examiner’s “statements are not pertinent to construing claim terms.” *Id.* Indeed, such statements “may be evidence of how one of skill in the art understood the term at the time the application was filed,” even if “an applicant’s silence regarding such statements does not preclude the applicant from taking a position contrary to the examiner’s statements when the claim terms are construed during litigation.” *Id.*

Here, the examiner’s statement does not preclude Force MOS from taking the position that “covered” does not mean “entirely covered.” But the statement does provide useful contemporaneous evidence of how “covered” would have been read by a skilled artisan in context. The Court concludes upon review of the language and structure of the claims, the specification, and the prosecution history that, in context, the disputed language from claim 1 means that the lateral contact layer *fully* covers the portions of the trench sidewalls that are within the base layer. This is the more natural reading of “covered,” and one which is strongly supported (even if not required) by the examiner’s explanation of the amended claim language. This interpretation also comports with the diagrams showing the preferred embodiment in the specification and is not contradicted by the “at a sidewall” language of the specification.

The Court therefore construes the disputed phrase as meaning: “portions of the sidewalls of said trenches that are within said base layer are entirely covered by the lateral contact layer.”

Term 2 (Force MOS '634 Patent, Claim 1)

Claim Language	“a plurality of trenched gates covered by said interlayer oxide film are formed on top of said source layer extending downwardly through said base layer to a portion of said epitaxial layer”
AOS Proposal	“a plurality of trenched gates are covered by an interlayer oxide film and extend from above the source layer downward through the base layer into the epitaxial layer”
Force MOS Proposal	plain and ordinary meaning / no express construction required
Court’s Construction	no additional construction necessary

The next disputed term appears earlier in the same claim, claim 1 of Force MOS’s ’634 patent. Here, the dispute is over how far down the gate trenches extend. Does “to a portion of said epitaxial layer” mean that the gates must extend *into* the epitaxial layer, or only to its top edge?

As the patent specification explains, the gate trenches are actually created before any of the relevant layers are formed. Figure 2A (at left below) shows a cross section after the gate trenches are formed in the epitaxial layer (202), but before the other layers are created. Figure 2C (at right) shows the same cross section after the base layer (205) and source layer (206) are created using an implantation procedure:

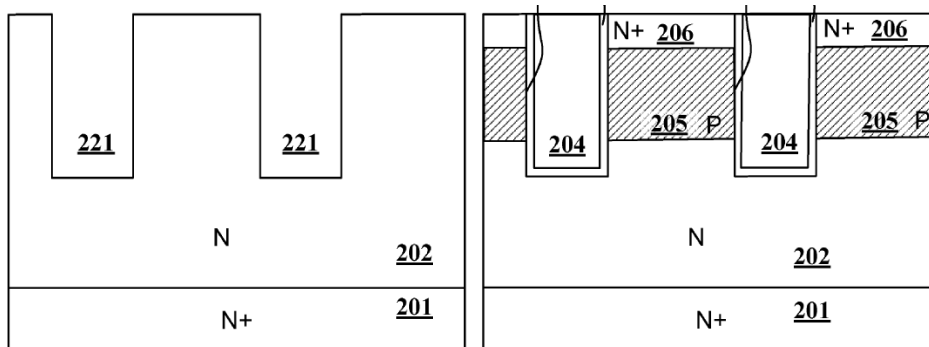


Fig. 2A

Fig. 2C

These figures clearly show the gate trenches extending not just to the edge of the epitaxial layer (202), but *into* the epitaxial layer. Certainly, construing the claim such that the trench could not extend beyond the top edge of the epitaxial layer would be inconsistent with these drawings.

Under a straightforward reading of the language—that the gate trench extends “to a portion of said epitaxial layer”—this claim plausibly covers both a trench that extends only to the edge of the epitaxial layer as well as a trench that extends past the top edge into that layer. Or, more accurately given the order of operations in manufacturing, it covers chips where the base layer extends to the bottom edge of the trench as well as chips where the bottom of the base layer stops above the bottom of the trench. This is the reading Force MOS urges. AOS’s reading would narrow the claim and limit it to only cases where the trench extended below the top edge of the epitaxial layer. AOS has provided no basis for the Court to do so. “Absent a clear disavowal in the specification or the prosecution history, the patentee is entitled to the full scope of its claim language.” *Thorner v. Sony Computer Entm’t Am. LLC*, 669 F.3d 1362, 1366 (Fed. Cir. 2012) (quoting *Home Diagnostics, Inc. v. LifeScan, Inc.*, 381 F.3d 1352, 1358 (Fed. Cir. 2004)). “It is ... not enough that the only embodiments, or all of the embodiments, contain a particular limitation,” because courts “do not read limitations from the specification into claims.” *Id.* Accordingly, the Court rejects AOS’s proposed limiting construction and concludes that this claim requires no additional express construction.

Term 3 (Force MOS ’346 Patent, Claim 1)

Claim Language	“a plurality of source contact trenches penetrating through said second insulating layer and said source regions with vertical sidewalls substantially perpendicular to a top epitaxial surface within said source regions, and further extending into said body regions with tapered sidewalls with respect to said top surface of said epitaxial layer”
AOS Proposal	“the source contact trenches have sidewalls that are vertical and substantially perpendicular to the top surface of the epitaxial layer in the source regions of the plurality of power cells, and sidewalls that are tapered with respect to the top surface of the epitaxial layer in the body regions of the plurality of power cells”
Force MOS Proposal	plain and ordinary meaning / no express construction required
Court’s Construction	no additional construction necessary

The third disputed term appears in the first claim of Force MOS’s ’346 patent. AOS argues that its proposed construction is “true to the plain meaning of the claim language.” Dkt. No. 80, at 21. It does not appear, however, that the parties have a specific “fundamental dispute” over the meaning of this term. *See O2 Micro Int’l Ltd. v. Beyond Innovation Tech. Co.*, 521 F.3d 1351, 1362 (Fed. Cir. 2008). The Court will therefore leave this term unconstrued at this stage.

Term 4 (Force MOS ’058 Patent, Claim 1)

Claim Language	“metallic contact plugs and said front metal are composed of a metallic material having a thermal conductivity higher than a thermal conductivity of aluminum and/or aluminum alloys”
AOS Proposal	indefinite, or “both the metallic contact plugs and the front metal are made of a metallic material that has a higher thermal conductivity than aluminum”
Force MOS Proposal	plain and ordinary meaning / no express construction required
Court’s Construction	not indefinite, “metallic contact plugs and said front metal are composed of a metallic material having a thermal conductivity higher than the thermal conductivity of aluminum”

AOS raises two challenges to this claim. First, AOS contends that it is not clear which “aluminum alloys” the claim refers to. AOS argues that if this claim includes *all* alloys of aluminum, this term is “meaningless and limitless.” Dkt. No. 57-1, at 3. Force MOS counters that the phrase “aluminum alloy” in the field of semiconductors is unambiguous. The indefiniteness inquiry focuses on whether the scope of an invention is reasonably certain. Breadth is not the same as uncertainty. Accordingly, even if the term “aluminum alloys” referred to all possible aluminum alloys, that alone would not render this term indefinite (although it may raise other problems); the term would be broad but clear. Here, though, Force MOS argues that a skilled artisan’s understanding of “aluminum alloys” in the context of this patent would be narrower than a layperson’s. Force MOS points to testimony on this patent from AOS’s expert that “an aluminum alloy in this art is understood to be a metal composed of aluminum and a small percentage of

another metal, specifically silicon, copper, or a combination of silicon and copper.” Dkt. No. 73-7, at 4. Because neither party asks the Court for a specific construction of “aluminum alloys,” the Court need not decide whether the term refers to all aluminum alloys or only to this narrower subset. In either case, though, the term “aluminum alloys” does not render the claim indefinite.

Second, because aluminum and its alloys have different levels of thermal conductivity, AOS contends that it is not clear what it means for a material to have a higher conductivity than “aluminum *and/or* aluminum alloys.” The confusion resulting from the inclusion of “and/or” in this claim stems from the fact that aluminum and its various allies have different levels of thermal conductivity: aluminum’s is around 237 watts per meter-kelvin while its alloys’ thermal conductivities are lower. Dkt. No. 80, at 25. AOS contends that there are two ways to read the “and/or” phrase. The first is that the “metallic material” must have a thermal conductivity higher than aluminum *and* any of its alloys. Because the alloys’ conductivities are all lower than aluminum’s, this is the same as saying that the metallic material must have a conductivity higher than aluminum’s. The second read is that the metallic material must have a thermal conductivity higher than either aluminum *or* any of its alloys. In other words, any material whose thermal conductivity was higher than that of the alloy with the lowest thermal conductivity would qualify.

Here, the context provided by the specification and other claims is instructive. The specification describes how in the prior art, the “source metal contact is ... electrically connected to the front metal composed of aluminum alloys,” and “[a]luminum wires are then formed on top” of the aluminum alloy front metal layer. ’058 Patent, col. 1. The specification then refers to the “thermal conductivity of such device,” in other words, the combination of aluminum wires and an aluminum alloy metal layer as was used in prior art devices. *Id.* Turning to the claim language, the full context reads:

... wherein said metallic contact plugs and said front metal are composed of a metallic material having a thermal conductivity higher than a thermal conductivity of aluminum and/or aluminum alloys ...

Id. col. 7. This claim language explicitly differentiates material used in the contact plugs and front metal from the prior art, where they might have been composed of aluminum alloys and

aluminum, respectively. Notably, the claim does *not* say that the metallic material’s conductivity must be “higher than the thermal conductivity of aluminum and/or the thermal conductivity of aluminum alloys.” Instead, it makes a comparison to the “thermal conductivity of aluminum and/or aluminum alloys.” This parallels the reference in the specification to the “thermal conductivity” of a “device” comprised of both aluminum and alloys. Thus, in full context, the best read of this term is that the contact plugs and front metal must be composed of a metallic material that has a thermal conductivity higher than any potential combination of aluminum and/or its alloys in such a “device.” Force MOS confirmed in its reply that this is the interpretation of “and/or” that it seeks. Dkt. No. 81, at 18 (“Force MOS asks the Court to find that the claim requires that the ‘metallic material’ have a higher thermal conductivity than aluminum, aluminum alloys, and combinations of aluminum and aluminum alloys.”). And because aluminum has a higher conductivity than any of its alloys, this means that the metallic material must have a thermal conductivity higher than aluminum’s. The structure and language of this claim are admittedly clunky. But in context of the claims and specifications, the language is not impermissibly uninformative regarding the claim’s scope.

Force MOS takes issue with AOS’s proposed construction, arguing that by using the term “made of” instead of “composed of,” the alternative construction “improperly suggest[s] the plugs and front metal must be made only of one material, and that one material’s thermal conductivity must be greater than that of aluminum.” Dkt. No. 74, at 25. Force MOS argues that, because the preferred embodiment identified also includes a layer of nickel (which has a thermal conductivity lower than aluminum’s) as part of the front metal, a construction that required that “both the plug and front metal must be ‘made of’ the same, single metal” would exclude this embodiment. *Id.* at 26. AOS’s main argument, however, is that the claim, with its reference to unspecified “alloys” and use of the phrase “and/or,” is indefinite (for the reasons discussed above). Because the Court has rejected the indefiniteness argument and has not adopted AOS’s alternative construction, it need not address Force MOS’s argument against that alternative. And while the Court will not construe “composed of” absent an actual dispute, the Court sees no apparent conflict between this claim as construed and the embodiment that includes a nickel layer in addition to gold or silver.

Finally, AOS points out that claim 1 uses the phrase “aluminum *and/or* aluminum alloys” but claims 2 and 3 use the term “aluminum *or* aluminum alloys.” Dkt. No. 80, at 26 n.7 (emphasis added). While the parties have not sought claim construction of this phrase in claims 2 and 3, AOS urges the Court to articulate whether and how the disjunctive phrases in the latter two claims have a different than the phrase in claim 1. Here, in context, these phrases all have the same meaning. Claim 1—the first time “aluminum” or “aluminum alloys” are referenced in the claims—uses the phrase “aluminum and/or aluminum alloys.” Claims 2 and 3 are the only other times “aluminum” or “aluminum alloys” are referenced. In both instances, the claims refer to “*said* aluminum or aluminum alloys” (emphasis added). In context, it is thus clear that the disjunctive phrases in claims 2 and 3 are referring back to the same conceptual phrase in claim 1, and that they should therefore have the same meaning as “aluminum and/or aluminum alloys.”

In sum, the Court concludes that this term is not indefinite. It is construed as meaning: “metallic contact plugs and said front metal are composed of a metallic material having a thermal conductivity higher than the thermal conductivity of aluminum.”

Term 5 (Force MOS '058 Patent, Claim 1)

Claim Language	“metallic contact plugs and said front metal comprises a continuous uninterrupted electrical and thermal conductivity conducting path from said semiconductor power device to said front metal”
AOS Proposal	indefinite, or “the metallic plugs form an electrical and thermal conducting path from the power cells to the front metal.”
Force MOS Proposal	plain and ordinary meaning / no express construction required
Court’s Construction	not indefinite, no additional construction necessary

Start with additional context from claim 1:

A vertical semiconductor power device comprising a plurality of semiconductor power cells connected to a bottom electric terminal

disposed on a bottom surface of a semiconductor substrate and at least a top electrical terminal disposed on a top surface of the substrate and connected to the semiconductor power cells, said semiconductor power device further comprising:

contact trenches opened through an insulation layer and extended into regions of said power cells wherein said contact trenches are filled with metallic contact plugs providing electrical and thermal conductivity contacts;

said top electrical terminal further comprising a solderable front metal disposed on top of said insulation layer and contacting said metal plugs penetrated through said insulation layer wherein ... said metallic contact plugs and said front [sic] metal comprises a continuous uninterrupted electrical and thermal conductivity conducting path from said semiconductor power device to said front metal.

'058 Patent, col. 7. As the language of the claim makes clear, both the metallic contact plugs and the front metal form part of the semiconductor power device. AOS argues that the claim is therefore “nonsense,” illogical, and invalid as a matter of law because it describes a path from the “semiconductor power device to said front metal” when both of the components that form the path—the contact plugs and the front metal—are part of the semiconductor power device.

This claim is not indefinite. The claim specifies that the metallic contact plugs extend “through an insulation layer ... into regions of said power cells” and provide “electrical and thermal conductivity contacts.” It then specifies that the front metal on the top of the insulation layer “contact[s]” the metal plugs forming a “continuous uninterrupted electrical and thermal conductivity path.” The terminus of that path is the front metal, as the claim specifies. And in context, the path can be retraced from the front metal to the contact plug that extends “into” the power cells. Since the power cells are part of the semiconductor power device, where the claim says the path starts, it is straightforward to piece together the path’s route. The claim is therefore not indefinite and requires no further construction.

Term 6 (AOS '361 Patent, Claim 1 and '265 Patent, Claim 1)

Claim Language	“the source lead bonding area and the gate lead bonding area being of increased area” ('361 Patent) “the gate lead bonding area and the source lead bonding area being of increased area” ('265 Patent)
AOS Proposal	“the source lead bonding area and the gate lead bonding area are larger than in conventional semiconductor packages to allow an increased number of bonding wires to be bonded thereto”
Force MOS Proposal	indefinite
Court's Construction	indefinite

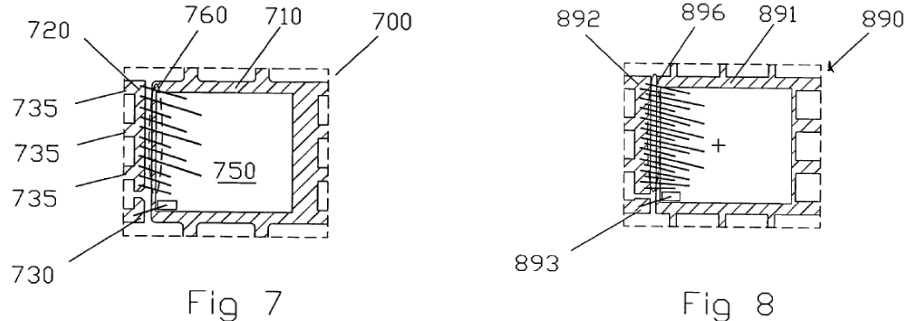
Functionally equivalent language appears in the first claim of both the '361 Patent and the '265 Patent. The '361 Patent is directed to the semiconductor package itself, while the '265 Patent is directed to the method of making that package. The parties seek the same construction of these two parallel terms and have briefed the two terms collectively.

The term “being of increased area” in both claims is one of degree that necessarily calls for comparison against some baseline. “Terms of degree are problematic if their baseline is unclear to those of ordinary skill in the art,” and “claims having terms of degree will fail for indefiniteness unless they provide objective boundaries for those of skill in the art when read in light of the specification and the prosecution history.” *Liberty Ammunition, Inc. v. United States*, 835 F.3d 1388, 1395–96 (Fed. Cir. 2016).

The question here is what the baseline is and whether it is sufficient to delineate the scope of the claim. Here, as in *Liberty Ammunition*, there is a claim term that is one of degree, for which the claim itself does not provide a baseline. In *Liberty Ammunition*, the term was “reduced area of contact.” 835 F.3d at 1395. The specification of the patent at issue there (which related to firearm ammunition) clarified that the patented projectile has “a reduced contact area as compared to

conventional projectiles.” *Id.* at 1396. The specification then identified one particular projectile as the kind of conventional projectile being improved upon. The Federal Circuit concluded that the specification’s mention of one specific conventional projectile “strongly suggest[ed]” that the mentioned projectile “is the point of comparison for the claims.” *Id.* Because the specification mentioned only one single projectile, and because at the time, that projectile was the standard-issue ammunition round for both NATO and the U.S. Army, the Federal Circuit concluded that the term of degree was not indefinite, and construed it in reference to the specifically mentioned standard projectile. *Id.* at 1397.

AOS argues that the baseline comparison here is equally definite. In particular, AOS points to Figures 7 and 8 from the specifications (the same figures appear in the specification of each patent). Figure 7 is “a schematic representation of a prior art 6×5 mm DFN semiconductor package,” and Figure 8 is “a schematic representation of a 6×5 mm DFN semiconductor package in accordance with the invention”:



AOS argues that this comparison between Figure 7—the “conventional” prior art package—and Figure 8 is analogous to the identification of a particular projectile in *Liberty Ammunition* and thus provides a sufficiently clear baseline comparison to render “being of increased area” definite.

Were AOS’s patents limited to 6×5 millimeter packages this argument would be more compelling. But the problem for AOS is that the patents are more generalized. Indeed, the specification includes schematic representations of a wide variety of sizes that the patent says are in accordance with the invention: not only 6×5 millimeters, but also 2×4, 3×3, and 2×3, for example. See ’361 Patent col. 3. These patents are thus distinguishable from the one at issue in

Liberty Ammunition where the fact that the specification referred to a single specific example of a conventional projectile was enough to enable the court to construe “reduced area of contact” as a comparison to that particular projectile. While the specification here provides a clear example of what it might mean for the source and gate lead bonding area to be of “increased area” as compared to one particular instance of a conventional package, this single sample schematic is not enough for a skilled artisan (or the Court) to be able to infer, as a more general matter, the source and gate lead bonding area of a “conventional” package against which the claimed increase should be measured. There is not enough in either the claims or specification for a skilled artisan to be reasonably certain of the scope of the claims. Because the specification fails to clearly set out the baseline against which “increased area” should be compared, the first claims of both the ’361 and ’265 patents are indefinite.

Term 7 (AOS ’304 Patent, Claim 1)

Claim Language	“contact zones”
AOS Proposal	plain meaning, i.e. “connection areas”
Force MOS Proposal	indefinite
Court’s Construction	not indefinite, no additional construction necessary

Force MOS contends that the term “contact zones” as it appears in claim 1 of the ’304 Patent renders the claim indefinite. AOS counters that it should have its plain and ordinary meaning, which AOS says is “connection areas.” Because the indefiniteness inquiry focuses on whole claims rather than particular terms, the Court begins with claim 1 in its entirety:

A power semiconductor device comprising:
a power semiconductor chip with a plurality of contact zones;
a dielectric layer overlaying the semiconductor surface extending over said plurality of contact zones and having a plurality of contact

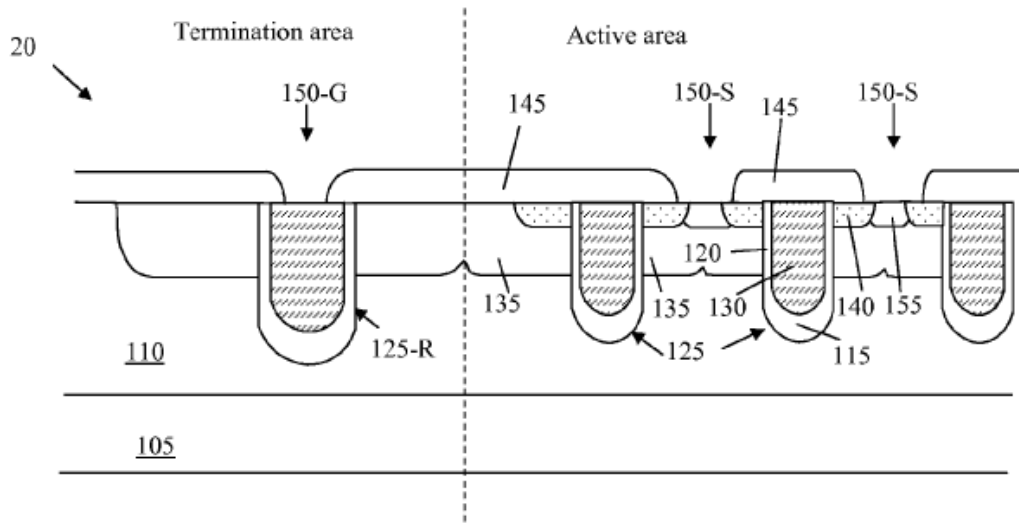
openings thereon;

a first metal layer having a thickness larger than 4 micron overlaying the dielectric layer contacting a plurality of source and body regions underlying the dielectric layer through the plurality of contact openings; and

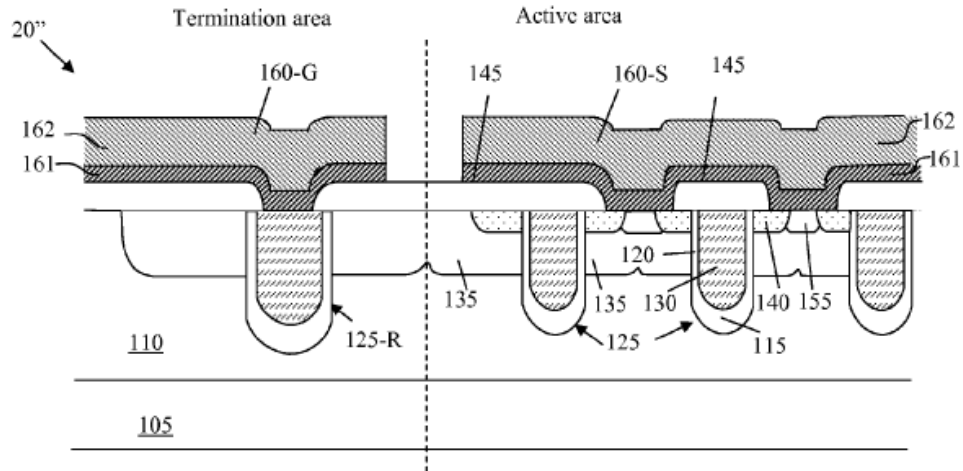
Cu bond wires connecting the metal layer to a plurality of source leads on a lead frame..

'304 Patent, col. 6.

This claim is not indefinite in light of the language of the claim and the patent's specification. Here is Figure 1B from the specification:



The dielectric layer referred to in claim 1 is labeled 145. The diagram also shows two kinds of contact openings. Source/body contact openings are labeled 150-S, and gate contact openings are labeled 150-G. The specification and diagrams thus make clear that "contact openings" are openings *in* the dielectric layer. Figure 3A shows how when the metal layer labeled 160 is added, the metal layer contacts the surface underneath the dielectric layer through the contact openings:



It is thus clear from the context provided by the specification that “contact zones” refers to the areas on the semiconductor surface below the dielectric layer that the metal layer contacts through the contact openings. Force MOS’s arguments that it is unclear what the differences are between “contact openings,” “contact zones,” and “source and body regions” are unconvincing. Contact openings are openings in the dielectric layer, while contact zones are the areas on the semiconductor surface that the metal layer contacts by virtue of extending *into* the contact openings. Additionally, with the added context of claim 2, it is clear that contact zones is used as an umbrella term, and that contact zones could comprise either “source and body regions” under the dielectric layer (as in claim 1), or “gate runners” (as in claim 2). In short, in context, the language of this claim is clear enough to provide sufficient notice of what is claimed and is therefore not indefinite.

Term 8 (AOS ’304 Patent, Claim 1)

Claim Language	“a first metal layer ... overlaying the dielectric layer contacting a plurality of source and body regions underlying the dielectric layer through the plurality of contact openings”
AOS Proposal	plain meaning, i.e., “the first metal layer overlays the dielectric layer, and by virtue of a plurality of contact openings, contacts a plurality of the source and body regions underlying the dielectric layer”
Force MOS Proposal	“a metal layer spreads over and covers the dielectric layer, and

portions of that metal layer must fill into the dielectric layer's contact openings such that those portions of the metal layer touch multiple source and body regions through respective multiple contact openings"

Court's Construction no additional construction necessary

There are two disputes here. First, the parties disagree what it means for the first metal layer to "overlay" the dielectric layer. Force MOS says "overlying" requires that the metal layer "spreads over and covers" the dielectric layer. AOS argues that this imports an additional limitation that the claim does not recite, and that the claim language simply requires that the metal layer is above the dielectric layer. Force MOS's proposed construction—that the first metal layer must cover the dielectric layer—is indeed consistent with the patent's specification as well as dictionary definitions, as Force MOS argues. But consistency is not enough to potentially narrow the meaning of the claim language. Merriam Webster defines "overlay" as "to lay or spread over or across," and it defines "spread" (at least in one sense) as "to cover or overlay something with." Not only does this phrasing suggest that cover and overlay can have slightly different meanings, but it also suggests that the meaning of this claim is not further clarified by swapping "overlay" for "spreads." Accordingly, the Court concludes that the term "overlying" does not require further construction.

Second, the parties disagree about what it means for the first metal layer to "contact" the source and body regions under the dielectric layer. Force MOS argues there must be physical contact. AOS responds that "contact" "is well understood in the semiconductor industry to refer to electrical contact." Dkt. No. 82, at 10. As with Force MOS's proposed construction of "overlying," reading "contact" as "physical contact" is again consistent with diagrams included in the specification, which appear to show physical contact, as well as some dictionary definitions. But, as before, that is not enough. That "a" dictionary definition of "contact" defines it as requiring "touching" is not enough, especially when another definition from that same dictionary also refers specifically to electrical contact as "a connection or point of connection between two conductors in a circuit." See Dkt. No. 79-3, at 6. As with "overlying," Force MOS has failed to

justify a construction of “contact” that would potentially narrow its meaning. “Contact” also does not require further construction.

Because neither of the disputed terms in this claim require further construction, the Court will not additionally construe this claim.

Term 9 (AOS '304 Patent, Claims 6 & 12)

Claim Language	“said first metal layer has a combined thickness of 4-5 micron for Cu wire bonding”
AOS Proposal	plain meaning, i.e., “the first metal layer has a combined thickness of 4-5 microns so as to allow copper wire bonding to it”
Force MOS Proposal	indefinite
Court’s Construction	not indefinite, “said first metal layer has a combined thickness of 4-5 microns so as to accommodate Cu wire bonding”

Force MOS argues that this claim is indefinite—“ungrammatical nonsense with varying potential interpretations.” Dkt. No. 90, at 17. Force MOS begins by noting that the patent examiner rejected similar language from a different proposed claim as vague and therefore indefinite. While the examiner’s reasoning may be instructive, claim construction and indefiniteness are questions of law which the Court must consider de novo. And in the excerpts Force MOS cites in its brief, the examiner appears to be expressing confusion over *why* this limitation was included (would “different thickness[es] ... form a Cu wire bonding” or would “only 4-5 micron of thickness act as Cu wire bonding”?), as opposed to confusion over what its language actually means. See Dkt. No. 79, at 17. Force MOS also argues that if “for Cu wire bonding” is simply a statement of intended purpose, the term would not constitute an actual limitation to the claims. *Id.* (citing *Boehringer Ingelheim Vetmedica, Inc. v. Schering-Plough Corp.*, 320 F.3d 1339, 1345 (Fed. Cir. 2003)). But even assuming the “for Cu wire bonding”

language does not add further limitation to the “thickness of 4-5 micron” language, that is not enough to render the entire claim indefinite. This claim is not indefinite.

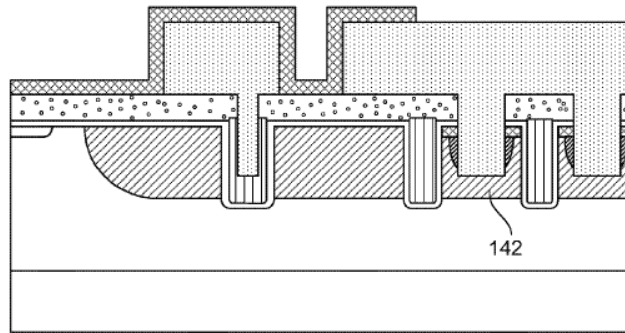
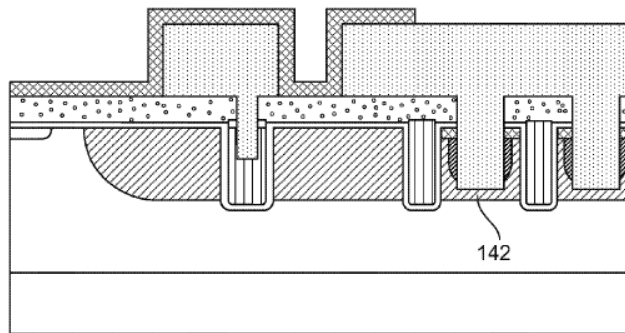
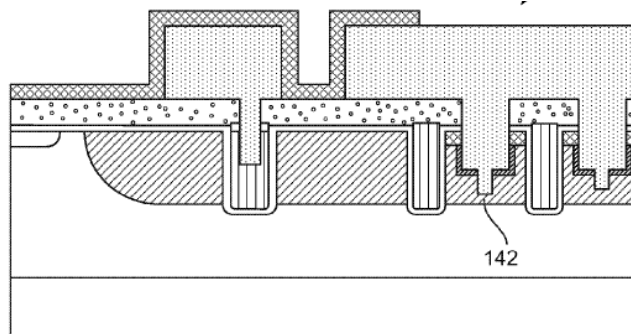
The specification explains that a “metal layer ... with a thickness between 3-6 micron, preferably between 4-5 micron” is required to “provide a bonding pad thick enough to accommodate Cu wire bonding.” ’304 Patent, col. 4. In light of this clarification, the Court construes this disputed term as meaning: “said first metal layer has a combined thickness of 4-5 microns so as to accommodate Cu wire bonding.”

Term 10 (AOS ’079 Patent, Claims 1 & 13)

Claim Language	“the thickness of the layer of body region is substantially less than the depth of the active region contact trench”
AOS Proposal	“the thickness of the layer of body region is substantially less than the depth of the active region contact trench, where the thickness of the layer of the body region is measured from the bottom of the active region contact trench to the bottom of the body and the depth of the active region contact trench is measured from the top surface of the substrate to the bottom of the active region contact trench”
Force MOS Proposal	indefinite
Court’s Construction	not indefinite, “the thickness of the layer of body region is less than one fifth of the depth of the active region contact trench”

Force MOS argues that the term “substantially” renders this claim indefinite. Both parties agree that terms of degree do not automatically render claims indefinite. *See Enzo Biochem, Inc. v. Applera Corp.*, 599 F.3d 1325, 1332 (Fed. Cir. 2010). But while “absolute or mathematical precision is not required, it is not enough ... to identify *some standard* for measuring the scope of the phrase.” *Interval Licensing LLC v. AOL, Inc.*, 766 F.3d 1364, 1370–71 (Fed. Cir. 2014) (cleaned up). “The claims, when read in light of the specification and the prosecution history, must provide *objective boundaries* for those of skill in the art.” *Id.* (emphasis added).

The question here is whether “substantially less” provides a meaningfully precise claim scope when read in light of the specification. AOS points to three pieces of additional information from the specification that it argues offer enough added context to provide sufficient objective boundaries for the claimed invention. First, the specification includes several figures that show examples of the trench and body region at issue:

**FIG. 1D****FIG. 1E****FIG. 1F**

In each of these figures, the thin layer of body region is labeled 142. And the trench is directly above that layer. Obviously, the ratio between the thickness of the body region and the trench above it is not the same in each of these figures. AOS estimates that the ratio is approximately 1:8 in Figure 1E and 1:4 in Figure 1D. Second, the specification provides ranges for the thicknesses of the body region and the trench for some of the exemplary embodiments: it specifies that the thickness of the body layer is between 0.01 and 0.5 microns thick, while the trench is between 0.2 and 2.5 microns thick (or as high as 3 microns thick after further processing). Third, the specification states that “[t]he thickness and the doping level of the thin body layer ... are adjusted so that in reverse bias this thin body layer is almost completely depleted while in forward bias the body layer is not depleted.” ’079 Patent, col. 5.

The third piece of context from the specification is not particularly helpful. As Force MOS points out, the statement that the thickness of the thin body layer is adjusted to satisfy certain criteria only relates to the thickness of that layer, not to its relationship to the depth of the trench. But the first two are instructive. Start with the figures. Under Federal Circuit precedent, “it is well established that patent drawings do not define the precise proportions of the elements and may not be relied on to show particular sizes if the specification is completely silent on the issue.” *Hockerson-Halberstadt, Inc. v. Avia Grp. Int’l, Inc.*, 222 F.3d 951, 956 (Fed. Cir. 2000). Here, the patent does not indicate that the figures are drawn to scale. But neither is the patent completely silent on the question. As an initial matter, the use of a term of degree in the claim suggests that the figures in the patents will be at least one relevant source in interpreting that term. And the inclusion of numerical ranges for the thicknesses of the body region and the trench provide additional guidance. In one sense, these numerical ranges are fairly precise because they involve actual numerical measurements. The challenge is that the ranges are broad and overlapping. The body layer ranges from 0.01 to 0.5 microns, while the trench ranges from 0.2 to 3 microns. But a term of degree like “substantially” necessarily involves the *ratio* between these two numbers, not just their respective ranges. AOS suggests looking to the ratio between the lower ends of each range and between the higher ends of each range. These are 1:20 on the low end and 1:5 or 1:6 on the high end. Force MOS counters that because the ranges overlap, it is possible to pick a

thickness from each range such that the body layer is actually thicker than the trench. Obviously this contradicts the claim language. But Force MOS's argument is that, because of this overlap, the ranges don't provide sufficient guidance.

Force MOS is correct that the term "substantially less," read in context of the figures and the specification's discussion of thickness ranges for the body layer and the trench, does not provide a precise cutoff for how much less thick the body region must be when compared to the trench. But absolute precision is not required. Here, the ratios between the upper and lower bounds of the respective ranges suggest that the trench must be, roughly, at least five times as deep as the body region is thick (2.5 microns, assuming no additional processing step, as compared to 0.5 microns). This is further reinforced by the fact that the drawings suggest approximately this same ratio. The Court thus concludes that in full context, the term "substantially less" provides a sufficiently objective boundary for the claim and means: "the thickness of the layer of body region is less than one fifth of the depth of the active region contact trench."

IV. Conclusion

The ten disputed terms shall be construed as set forth above.

Pursuant to the parties' prior stipulation, the deadline to complete ADR is July 9, 2024. No other deadlines are currently set. The parties are therefore directed to meet and confer to discuss the remaining schedule. By March 29, 2024 they shall either file a stipulation proposing a case schedule (including a trial date and all other deadlines identified in the local rules and this Court's standing order) if they agree, or a notice requesting a Case Management Conference if not.

IT IS SO ORDERED.

Dated: March 11, 2024



P. Casey Pitts
United States District Judge