United States Court of Appeals for the Federal Circuit

BIO-RAD LABORATORIES, INC., THE UNIVERSITY OF CHICAGO,
Plaintiffs-Appellees

v.

10X GENOMICS INC.,
Defendant-Appellant

2019-2255, 2019-2285

Appeals from the United States District Court for the District of Delaware in No. 1:15-cv-00152-RGA, Judge Richard G. Andrews.

Decided: August 3, 2020

EDWARD R. REINES, Weil, Gotshal & Manges LLP, Redwood Shores, CA, argued for plaintiffs-appellees. Also represented by CHRISTOPHER SHAWN LAVIN, DEREK C. WALTER.

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Redwood Shores, CA.

STEVEN R. TRYBUS, Locke Lord LLP, Chicago, IL, for amicus curiae The Broad Institute, Inc.

Before NEWMAN, O'MALLEY, and TARANTO, *Circuit Judges*.

O'MALLEY, *Circuit Judge*.

Bio-Rad Laboratories, Inc. and the University of Chicago (collectively, "Bio-Rad"), accused 10X Genomics Inc. ("10X") of infringing three patents: U.S. Patent Nos. 8,889,083 ("'083 patent"); 8,304,193 ("'193 patent"); and 8,329,407 ("'407 patent"). The United States District Court for the District of Delaware held a jury trial in November 2018. The jury found all three patents valid and willfully infringed. It also awarded damages in the amount of $23,930,716. Post-trial, the district court denied 10X's motion for judgment as a matter of law ("JMOL") under Federal Rule of Civil Procedure 50(b), rejecting 10X's arguments that (1) the accused products do not infringe; (2) 10X's infringement was not willful; (3) the asserted claims are invalid; and (4) Bio-Rad had failed to present a legally sufficient damages case. *Bio-Rad Labs. Inc. v. 10X Genomics, Inc.*, 396 F. Supp. 3d 369 (D. Del. 2019). The district court also granted Bio-Rad's motion for a permanent injunction. *Bio-Rad Labs. Inc. v. 10X Genomics, Inc.*, No. 15-cv-152-RGA, 2019 WL 3322322, at *1 (D. Del. July 24, 2019). This appeal followed. For the reasons discussed below, we affirm-in-part, reverse-in-part, vacate-in-part, and remand. Specifically, we affirm the judgment of infringement of the '083 patent and the entirety of the jury's damages award. We reverse, however, the district court's construction of the asserted claims of the '407 and '193 patents and vacate the judgment of infringement of those patents. We remand for a new trial on the issue of whether 10X's accused products infringe the '407 and '193 patents under the proper claim construction. We also vacate the

district court's injunction, but only with respect to 10X's Linked-Reads and CNV product lines.

I. BACKGROUND

A. The Claimed Technology and the Patents-in-Suit

The patents-in-suit are directed to systems and methods for forming microscopic droplets (also called "plugs") of fluids to perform biochemical reactions. Microfluidic systems—often called "labs-on-a-chip"—allow scientists to conduct microscale chemical and biological reactions. For example, the technology allows scientists to analyze and compare DNA, RNA, and proteins within large numbers of *individual* cells. This technology therefore has applications in medical diagnostics and high-throughput screening.

Microfluidic systems utilize chips that have "microfluidic channels," hair-width pathways through which cells and fluids flow. In these systems, biological samples can be partitioned into single-cell-width droplets, which function as mini-test tubes. Each droplet holds a single cell and the required reagents for the biochemical reaction. Droplets are formed by "pinching off"—flowing a carrier-fluid and substrate/plug-fluid (which are immiscible with each other) through the microfluid channels and applying pressure. The biochemical reactions may occur "on chip," *i.e.*, in the channels inside the microchips, or, the droplets may be collected to allow the reactions to occur "off chip."

The parties agree that claim 1 of the '083 patent, copied below, is representative.

> 1. A microfluidic system comprising:
>
> a non-fluorinated microchannel;
>
> a carrier fluid comprising a fluorinated oil and a fluorinated surfactant comprising a hydrophilic head group in the microchannel;

> at least one plug comprising an aqueous plug-fluid in the microchannel and substantially encased by the carrier-fluid, wherein the fluorinated surfactant is present at a concentration such that surface tension at the plug-fluid/microchannel wall interface is higher than surface tension at the plug-fluid/carrier fluid interface.

'083 patent, claim 1.

During prosecution of the '083 patent, the inventors amended the claims to overcome a rejection based on the prior art U.S. Patent No. 7,294,503 ("Quake"). Quake disclosed microchannels formed or coated with Teflon (a fluorinated polymer) or other fluorinated oils. The inventors distinguished the prior art by arguing that, unlike Quake, the as-filed application for the '083 patent attempts to prevent droplets from sticking to the walls of microchannels and requires that the "surfactant should be chemically similar to the carrier fluid and chemically different from the channel walls." J.A. 16640. The inventors amended the claims to require non-fluorinated microchannels and a fluorinated surfactant, which would not react with each other.[1] They explained that, as amended, the claims were

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[1] The amendment at issue added the claim limitations shown in underlined text below:

> A microfluidic system comprising:
>
> a <u>non-fluorinated</u> microchannel;
>
> a carrier fluid comprising a fluorinated oil and a <u>fluorinated</u> surfactant <u>comprising a hydrophilic head group</u> in the microchannel;
>
> at least one plug comprising an aqueous plug-fluid in the microchannel and substantially encased by the carrier-fluid, wherein the <u>fluorinated</u> surfactant is present at a concentration such that surface

distinct from Quake, which did not teach microchannels and carrier fluids that were chemically distinct. Rather, in their view, Quake taught coating the microchannels with a fluorinated oil and using fluorinated surfactants in the carrier fluid. The fluorinated microchannels and surfactants could, therefore, react with each other.

The other two asserted patents, the '407 and the '193 patents, are continuations of the same parent application. Claim 1 of the '407 patent is reproduced below:

> 1. A method for conducting a reaction in plugs in a microfluidic system, comprising the steps of:
>
> providing the microfluidic system comprising at least two channels having at least one junction;
>
> continuously flowing an aqueous fluid containing at least one biological molecule and at least one reagent for conducting the reaction between the biological molecule and the at least one reagent through a first channel of the at least two channels;
>
> continuously flowing a carrier fluid immiscible with the aqueous fluid through the second channel of the at least two channels;
>
> forming at least one plug of the aqueous fluid containing the at least one biological molecule and the at least one reagent by partitioning the aqueous fluid with the flowing immiscible carrier fluid at the junction of the at least two channels, the plug being substantially surrounded by the immiscible carrier fluid flowing through the channel, wherein the at

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> tension at the plug-fluid/microchannel wall interface is higher than surface tension at the plug-fluid/carrier fluid interface.

J.A. 16635.

> least one plug comprises at least one biological molecule and the at least one reagent for conducting the reaction with the at least one biological molecule; and
>
> providing conditions suitable for the reaction in the at least one plug involving the at least one biological molecule and the at least one reagent to form a reaction product.

'407 patent, claim 1.

The only independent claim of the '193 patent is identical to claim 1 of the '407 patent, except that it specifies "an autocatalytic reaction" instead of a biological reaction. 10X maintains that its arguments regarding the '407 patent "apply equally to the '193 patent unless otherwise noted." Appellant's Br. 44 n.3.

B. The Accused Products

10X has five accused product lines: Single Cell 3' Gene Expression, Linked-Reads, Single Cell V(D)J, Single Cell ATAC-seq, and Single Cell CNV. 10X claims to have successfully invented non-infringing alternatives for three of its five product lines but has not yet been able to design a replacement for two: Linked-Reads and Single Cell CNV.

Each product line uses a hardware instrument, microfluidic chips, and a variety of specialized reagents. The hardware instrument is called a "controller." The disposable microfluidic chips, which fit in the instrument, have networks of "microfluidic channels," each about the width of a human hair. In the accused products, droplets are formed at junctions in the microfluidic channels. The reagents encompass a variety of products such as enzymes, DNA barcodes, and 10X's proprietary microscopic beads.

The record does not establish which 10X products correspond to each of the product lines. For the '083 patent, there were 6 accused products: Chromium Genome/Exome;

Chromium Genome/Exome with Kynar; GemCode Long Read; Chromium Single Cell 3'; Chromium Single Cell 3' with Kynar; and Chromium Single Cell V(D)J with Kynar. The jury found that all six products infringe all asserted claims (claims 1 and 9) of the '083 patent. For the '193 patent, there were two accused products: Chromium Genome/Exome and GemCode Long Read. The jury found both products infringe all asserted claims (claims 6 and 8) of the '193 patent. For the '407 patent, there were four accused products: Chromium Genome/Exome; GemCode Long Read; Chromium Single Cell 3'; and Chromium Single Cell V(D)J. The jury found these products infringe the asserted claims (claims 1, 10, and 11).

C. Procedural History

In February 2015, patent owner University of Chicago and its licensee RainDance Technologies, Inc. ("RainDance") filed this patent infringement suit against 10X. Bio-Rad subsequently purchased RainDance and, in May 2017, was substituted for RainDance in the litigation. After the litigation was filed, 10X modified its products to add 0.02% Kynar—a non-reactive amount of a fluorine-containing resin—to its microchannels. 10X concedes that the addition of this amount of Kynar is irrelevant to the functioning of its products. The district court held a jury trial in November 2018. The jury found the patents-in-suit not invalid and willfully infringed. The jury then awarded Bio-Rad damages in the amount of $23,930,716.

10X moved for JMOL, asserting that the accused products do not infringe, that its infringement was not willful, that the asserted claims are not valid, and that Bio-Rad failed to present a legally sufficient damages case. 10X also requested a remittitur and moved for a new trial. On July 3, 2019, the district court denied 10X's motion. Bio-Rad, for its part, moved for a permanent injunction, attorneys' fees, enhanced damages, supplemental damages, and pre- and post-judgment interest. On July 24, 2019, the district

court granted the motion with respect to the permanent injunction, supplemental damages, and pre- and post-judgment interest, but denied the motion with respect to attorneys' fees and enhanced damages. This appeal followed.[2] We have jurisdiction pursuant to 28 U.S.C. §§ 1295(a)(1) and 1292(c)(2).

II. DISCUSSION

We review a denial of JMOL or new trial under the law of the regional circuit. *Energy Transp. Grp., Inc. v. William Demant Holding A/S*, 697 F.3d 1342, 1350 (Fed. Cir. 2012). The Third Circuit "exercise[s] plenary review of an order granting or denying a motion for judgment as a matter of law and appl[ies] the same standard as the district court." *Lightning Lube, Inc. v. Witco Corp.*, 4 F.3d 1153, 1166 (3d Cir. 1993). JMOL is "granted only if, viewing the evidence in the light most favorable to the nonmovant and giving it the advantage of every fair and reasonable inference, there is insufficient evidence from which a jury reasonably could find" for the nonmovant. *Id.* The decision to grant or deny

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[2] On August 19, 2019, 10X filed a Rule 8 Motion for a Stay Pending Appeal, seeking a stay of the district court's injunction order. We initially ruled that 10X could continue to sell its Linked-Reads and CNV products subject to the royalty and deposit requirements set forth in the district court's injunction order. Order, *Bio-Rad Labs., Inc. v. 10X Genomics Inc.*, No. 2019-2255 (Fed. Cir. Aug. 19, 2019). On September 24, 2019, we concluded that our prior stay order should remain in effect during the pendency of the appeal, noting that "10x Genomics indicates that, while it did not immediately have available to offer to new customers an instrument that would be capable of running only [the Linked-Reads and CNV] products, it could, in a matter of weeks, implement such a solution." Order, *Bio-Rad Labs., Inc. v. 10X Genomics Inc.*, No. 2019-2255, at *2 (Fed. Cir. Sept. 24, 2019).

a new trial is committed to the discretion of the district court, which grants a new trial only where "a miscarriage of justice would result if the verdict were to stand" or where the verdict "shocks [the] conscience." *Williamson v. Consol. Rail Corp.*, 926 F.2d 1344, 1353 (3d Cir. 1991).

On appeal, 10X argues that (1) it is entitled to JMOL of non-infringement of the three patents-in-suit; (2) the damages award should be vacated because it was based on both inadmissible and insufficient evidence; and (3) the district court abused its discretion in enjoining all five product lines. We address these arguments in turn.

A. Infringement of the '083 Patent

The asserted claims of the '083 patent recite "non-fluorinated microchannels." As of trial, 10X's accused products contained microchannels with 0.02% Kynar—a fluorine-containing coating resin. The jury found that 10X's accused products, as modified, do not literally satisfy the "non-fluorinated microchannels" limitation but meet the limitation under the doctrine of equivalents. On appeal, 10X argues that the district court erred in denying JMOL because "two independent legal principles" barred Bio-Rad's theory of equivalence: prosecution history estoppel and claim vitiation. Appellant's Br. 31–40. It also argues that its products cannot satisfy one of the claim limitations relating to the surface tension at the plug-fluid/carrier-fluid interface. As discussed below, we reject 10X's arguments.

1. Bio-Rad Was Not Estopped From Asserting the Doctrine of Equivalents

"[E]quivalents remain a firmly entrenched part of the settled rights protected by the patent." *Festo Corp. v. Shoketsu Kinzoku Kogyo Kabushiki Co.*, 535 U.S. 722, 733 (2002) ("*Festo I*"). There are certain limitations, however, on a patentee's ability to obtain an infringement verdict under the doctrine of equivalents. One such limitation is

prosecution history estoppel. *See, e.g.*, *id.* at 737–40. Another limitation—the doctrine of claim vitiation—ensures that "the application of the doctrine [of equivalents] . . . is not allowed such broad play as to effectively eliminate [a claim] element in its entirety." *Warner-Jenkinson Co. v. Hilton Davis Chem. Co.*, 520 U.S. 17, 29 (1997). Both are at issue in this appeal.

a. Prosecution History Estoppel

Prosecution history estoppel arises when a patent applicant narrows the scope of his claims during prosecution for a reason "substantial[ly] . . . relating to patentability." *See generally Festo Corp. v. Shoketsu Kinzoku Kogyo Kabushiki Co.*, 344 F.3d 1359, 1366–67 (Fed. Cir. 2003) (en banc) ("*Festo II*"). A narrowing amendment is presumed to be a surrender of all equivalents within "the territory between the original claim and the amended claim." *Festo I*, 535 U.S. at 740. This presumption can be overcome if the patentee can show that one of the following "exceptions" to prosecution history estoppel applies: (1) the rationale underlying the amendment bears no more than a tangential relation to the equivalent in question; (2) the equivalent was unforeseeable at the time of the application; or (3) there was some other reason suggesting that the patentee could not reasonably be expected to have described the equivalent. *Id.* at 740–41.

"[W]hether prosecution history estoppel applies, and hence whether the doctrine of equivalents may be available for a particular claim limitation, presents a question of law." *Festo II*, 344 F.3d at 1367–68. In making this determination, we must "look to the specifics of the amendment and the rejection that provoked the amendment to determine whether estoppel precludes the particular doctrine of equivalents argument being made." *Intervet Inc. v. Merial Ltd.*, 617 F.3d 1282, 1291 (Fed. Cir. 2010).

The district court held that prosecution history estoppel does not apply in this case because the amendment at

issue was only tangentially related to the accused equivalent. The court reasoned that, during prosecution, the inventors sought to distinguish the microchannels in their system from fluorinated prior art microchannels that would react with the carrier fluid. *Bio-Rad*, 396 F. Supp. 3d at 377. In the court's view, the objectively apparent reason for the amendment was to distinguish fluorinated microchannels from microchannels that had no fluorinated properties. The district court concluded that an accused product like 10X's—having minute or negligible quantities of fluorine that have no function in the product and do not react with the microchannels—could meet the "non-fluorinated" limitation under the doctrine of equivalents. *Id.*

On appeal, the parties do not dispute that the amendment at issue was narrowing, or that it was made to overcome prior art. Instead, they dispute whether the tangentiality exception to prosecution history estoppel applies. 10X argues, as it did before the district court, that prosecution history estoppel applies because the '083 patent inventors narrowed the claims to recite a "non-fluorinated microchannel" to overcome Quake, which taught "fluorinated" microchannels. 10X argues that, with this amendment, the inventors surrendered all territory between the original limitation—microchannels generally—and the amended limitation—non-fluorinated microchannels. Appellant's Br. 33–34. Accordingly, 10X contends that the district court erred in applying the "tangentiality" exception for a narrowing amendment. 10X characterizes the district court's analysis as "recasting" the inventors' disclaimer as covering only microchannels coated with fluorine "for a purpose." *Id.* at 35 (emphasis omitted). In 10X's view, by rewriting the claims during prosecution, the inventors surrendered the right to expand their monopoly to cover microchannels containing fluorine, "for whatever purpose." *Id.* at 36.

Bio-Rad argues that the tangentiality exception to prosecution history estoppel allows it to assert and prevail

under the doctrine of equivalents. In Bio-Rad's view, the reason for narrowing the claims was "peripheral, or not directly relevant to the alleged equivalent." Appellees' Br. 20 (quoting *Festo II*, 344 F.3d at 1369). Bio-Rad contends that the patentees amended the claims to make clear that the carrier fluid and the microchannel wall should be chemically distinct, which bears no more than a tangential relation to the alleged equivalent—microchannel walls containing a nominal amount of fluorine that is not chemically distinct from the carrier fluid. We agree with Bio-Rad.

The prosecution history of the '083 patent establishes that the objectively apparent reason for adding the "non-fluorinated microchannels" limitation was no more than tangentially related to the equivalent at issue. In amending the claims, the patentees sought to distinguish the claimed invention from Quake, which disclosed fluorinated microchannel wall coatings that would react with the carrier fluid. The inventors argued that preventing droplets from sticking to the walls of the microchannels requires the surfactant to be chemically similar to the carrier fluid *and* chemically different from the channel walls. The inventors therefore amended the claims to make clear that the carrier fluid and the microchannel wall should be chemically distinct. By claiming non-fluorinated microchannels and a fluorinated surfactant, the inventors made sure that, in contrast to the Quake disclosure, the carrier fluid and microchannels in the claimed invention would not react with each other, thereby preventing droplets from sticking to the walls of the microchannels. As such, the inventors' decision to add the "non-fluorinated microchannels" limitation must be considered in the context of adding, at the same time, the limitation of a "fluorinated surfactant" to the carrier fluid.

The inventors' statements during prosecution confirm that the "rationale underlying the [narrowing] amendment [bore] no more than a tangential relation to the equivalent

in question"—here, microchannels containing negligible amounts of fluorine, which cannot react with the carrier fluid. *See Festo I*, 535 U.S. at 740–41. As the district court explained, the inventors surrendered microchannels coated with fluorine "*for a purpose*—not those containing *de minimis* amounts of fluorine that have no effect on how the microchannel functions in the system." *Bio-Rad*, 396 F. Supp. 3d at 377 (emphasis added). As such, Bio-Rad was not barred from asserting that microchannels containing negligible amounts of fluorine are equivalent to "non-fluorinated microchannels."

We reject 10X's argument that the "Quake patent unambiguously contained the accused equivalent," and therefore, this amendment cannot be tangential. Appellant's Br. 34–35. The crux of the tangentiality inquiry remains "the patentee's objectively apparent reason for the narrowing amendment . . . [as] discernible from the prosecution history record." *Festo II*, 344 F.3d at 1369. As explained above, the prosecution history record reveals that the reason for the amendment was to distinguish microchannels that reacted with carrier fluids. Quake disclosed fluorinated microchannels generally. It did not expressly disclose microchannels with non-reacting, negligible levels of fluorine, like in the accused equivalent. The question here is not whether Quake disclosed fluorinated microchannels, but rather, whether Quake taught the use of non-reactive amounts of fluorination in the microchannels. It did not. Accordingly, the narrowing amendment can only be said to have a tangential relation to the equivalent at issue—negligibly fluorinated microchannels, or, put differently, microchannels with non-fluorinated properties.

The parties each cite several of our cases in support of or against the application of the tangentiality exception to prosecution history estoppel. Prosecution history estoppel, including the tangentiality inquiry, is always a case-specific analysis. The objectively apparent reason discernable from the prosecution history record will, accordingly, differ

in each case. For example, we recently considered these issues in *Amgen Inc. v. Amneal Pharmaceuticals LLC*, 945 F.3d 1368 (Fed. Cir. 2020). There, the accused product used "pregelatinized starch" as a binder, and the asserted claim did not list pregelatinized starch in its Markush group reciting binders. *Id.* at 1380. The patent owner asserted infringement under the doctrine of equivalents, arguing that pregelatinized starch functioned as a binder in the accused product. We noted that the patent owner revised the claim's binder limitations to be in Markush group format to overcome prior art references that taught the use of pregelatinized starch as a binder. *Id.* at 1382. Accordingly, we concluded that the amendment—made to avoid prior art that contains the equivalent in question—was not tangential. *Id.* Because the prior art references at issue taught the use of the alleged equivalent for the claimed function, the tangentiality exception to prosecution history estoppel could not apply. Here, by contrast, Quake did not teach the use of the alleged equivalent—negligibly fluorinated microchannels or those with no fluorinated properties.

We also recently addressed the tangentiality exception in *Eli Lilly v. Hospira, Inc.*, where the patent owner narrowed the claims during prosecution to recite "pemetrexed disodium" instead of "an antifolate." 933 F.3d 1320, 1325–26 (Fed. Cir. 2019). The accused equivalent at issue was pemetrexed *ditromethamine*, which is functionally identical to pemetrexed disodium. *Id.* at 1327. We concluded that "[t]he reason for Lilly's amendment . . . was to narrow original claim 2 to avoid Arsenyan, which only discloses treatments using methotrexate, a different antifolate." *Id.* at 1331. Thus, claiming the functionally equivalent pemetrexed salts was tangential to overcoming prior art disclosing an antifolate other than pemetrexed. Here too, functionally equivalent microchannels (*i.e.*, microchannels with no fluorinated properties) are tangential to the patentees' reason for distinguishing Quake, which

disclosed fluorinated microchannels. We find this case more analogous to *Eli Lilly* than to *Amgen*.

Accordingly, we conclude that the district court correctly held that prosecution history estoppel does not apply in this case.

b. Claim Vitiation

Claim vitiation presents another bar to a finding of infringement under the doctrine of equivalents. "[S]aying that a claim element would be vitiated is akin to saying that there is no equivalent to the claim element in the accused device based on the well-established 'function-way-result' or 'insubstantial differences' tests." *Brilliant Instruments, Inc. v. GuideTech, LLC*, 707 F.3d 1342, 1347 (Fed. Cir. 2013). More recently, we have explained that vitiation "is not an exception or threshold determination that forecloses resort to the doctrine of equivalents, but is instead a legal conclusion of a lack of equivalence based on the evidence presented and the theory of equivalence asserted." *UCB, Inc. v. Watson Labs., Inc.*, 927 F.3d 1272, 1283 (Fed. Cir. 2019) (quoting *Cadence Pharm. Inc. v. Exela PharmSci Inc.*, 780 F.3d 1364, 1371 (Fed. Cir. 2015)); *see also DePuy Spine, Inc. v. Medtronic Sofamor Danek, Inc.*, 469 F.3d 1005, 1017 (Fed. Cir. 2006) ("[T]he 'all elements' rule generally is not met—and therefore a claim limitation can be said to be vitiated—if the theory or evidence of equivalence is legally incapable of establishing that the differences between the limitation in the claim and the accused device are insubstantial; *i.e.*, if the theory or evidence is so legally insufficient as to warrant a holding of non-infringement as a matter of law.").

On appeal, 10X argues that the doctrine of equivalents is unavailable to Bio-Rad because "fluorinated" and "non-fluorinated" are "diametric opposites" and because a fluorinated microchannel is the "antitheses" of a non-fluorinated microchannel. Appellant's Br. 37–40 (citing, e.g., *Moore U.S.A., Inc. v. Standard Register Co.*, 229 F.3d 1091,

1115 n.5 (Fed. Cir. 2000)). In 10X's view, allowing Bio-Rad to argue that fluorinated microchannels are equivalent to non-fluorinated microchannels entirely vitiates the "non-fluorinated microchannel" limitation. 10X also cites several of our prior cases where we found that a claim element cannot be supplied by an alleged equivalent that was the opposite of the missing element. Despite some surface appeal, these arguments do not hold up under even minimal scrutiny.

10X attempts to extend our cases regarding claim vitiation beyond their facts. Relying on *Deere & Co. v. Bush Hog, LLC*, 703 F.3d 1349, 1356 (Fed. Cir. 2012), the district court concluded that a reasonable jury could find on the facts presented here that non-fluorinated microchannels and minimally-fluorinated microchannels with no reactive properties are equivalent. 10X criticizes the district court's reliance on *Deere* as "invok[ing] only dicta." Appellant's Br. 39. It also argues that *Deere* did not override our prior cases discussing "opposites" but instead dealt with a scenario where the claim element did not present a binary choice. Appellant's Reply Br. 7. 10X, however, ignores the fact that we have repeatedly emphasized the principle outlined in *Deere* in subsequent cases. *See, e.g.*, *Cadence Pharm. Inc.*, 780 F.3d at 1371 (collecting cases).

In *Brilliant Instruments*, for example, we explained that vitiation comes into play when the alleged equivalent is "diametrically opposed" to the missing claim element. "[W]hen the accused structure has an element that is the opposite of the claimed element," it is "more difficult" for a patentee to succeed on a theory of equivalents. 707 F.3d at 1347. We also explained that "[i]f the claimed and accused elements are recognized by those of skill in the art to be opposing ways of doing something, they are likely not insubstantially different." *Id.* at 1347–48. And, we noted, "this concept [applies] to cases where we have recognized that two alternatives exist that are very different from each other and therefore cannot be equivalents for

infringement purposes." *Id.* at 1348 (citing, e.g., *Moore U.S.A., Inc.,* 229 F.3d at 1106).

Notably, in *Cadence Pharmaceuticals*, we cautioned against using labels like "antithesis" in lieu of conducting the proper inquiry of infringement under the doctrine of equivalents:

> Characterizing an element of an accused product as the "antithesis" of a claimed element is also a conclusion that should not be used to overlook the factual analysis required to establish whether the differences between a claimed limitation and an accused structure or step are substantial *vel non*. The determination of equivalence depends not on labels like "vitiation" and "antithesis" but on the proper assessment of the language of the claimed limitation and the substantiality of whatever relevant differences may exist in the accused structure.

Cadence Pharm., 780 F.3d at 1372.

Accordingly, we reject 10X's attempt to limit the inquiry to a binary choice between "fluorinated" and "non-fluorinated" microchannels, and its conclusion that infringement under the doctrine of equivalents is unavailable to Bio-Rad as a matter of law. The appropriate inquiry is whether a reasonable juror could have found that a negligibly-fluorinated microchannel performs the same function, in the same way, and achieves the same result, as a non-fluorinated microchannel. Here, based on the evidence presented at trial—including the testimony of Bio-Rad's expert, Dr. Sia—the district court concluded that a reasonable juror could find that a 0.02% Kynar-containing microchannel is insubstantially different from a non-fluorinated microchannel. *Bio-Rad*, 396 F. Supp. 3d at 378. The non-fluorinated microchannel claim limitation is not stripped of meaning, or "effectively eliminate[d]," *Warner-Jenkinson*, 520 U.S. at 29, by Bio-Rad's theory and the

jury's finding that the accused microchannel, having too little fluorine to alter its reactive properties, is an equivalent.

10X does not challenge that substantial evidence supports the jury's finding that a 0.02% Kynar-containing microchannel is insubstantially different from a non-fluorinated microchannel. Accordingly, 10X's challenges concerning the infringement under the doctrine of equivalents fail.

2. Substantial Evidence Supports the Jury's Verdict that 10X's Accused Products Meet the Claimed Surface Tension Relationship

10X next argues that it is entitled to JMOL of non-infringement of the '083 patent because none of its products have a plug-fluid/microchannel wall interface. Appellant's Br. 40–42. According to 10X, without such an interface, its products cannot satisfy the claim limitation "wherein the fluorinated surfactant is present at a concentration such that the surface tension at the plug-fluid/microchannel wall interface is higher than the surface tension at the plug-fluid/carrier-fluid interface." *Id.* at 40 (quoting '083 patent, col. 73 ll. 16–21) (emphasis omitted). 10X contends that the droplets in its chips are fully encased by the carrier fluid and do not touch the channel wall, meaning they do not have the plug-fluid/microchannel wall interface, and thus cannot infringe.

Bio-Rad responds that the claims do not require the plug-fluid to be in actual physical contact with the microchannel walls. Appellees' Br. 24. In Bio-Rad's view, the asserted claims merely require that the droplet/wall surface tension is higher than the droplet/carrier-fluid surface tension. According to Bio-Rad, the purpose of the claimed surface tension relationship is to allow the formation of plugs/droplets that do not stick to the channel walls, just like those in 10X's products. *Id.* at 25. We again agree with Bio-Rad.

The district court correctly noted that the claims do not require direct contact between the plug-fluid and the microchannel wall. They only require that the surface tension at the plug-fluid/microchannel wall interface is higher than that between the carrier fluid and the plug fluid. The specification explains the purpose of this claimed surface tension relationship: "If this condition is not satisfied, plugs tend to adhere to the channel walls and do not undergo smooth transport." '083 patent, col. 20 ll. 56–58. And, the specification clearly sets forth the purpose of introducing the surfactant:

> Because the walls of the channels (PDMS, not fluorinated) and the carrier-fluid (fluorinated oil) are substantially different chemically, when a fluorinated surfactant is introduced, the surfactant reduces the surface tension at the oil-water interface preferentially over the wall-water interface. This allows the formation of plugs that do not stick to the channel walls.

Id. at col. 20 l. 63–col. 21 l. 2. Given this, we find that 10X's argument that its accused products cannot meet this limitation is without merit.

We also agree with the district court that sufficient evidence supports the jury's finding that 10X's products meet the claimed surface tension limitation. 10X's own expert, Dr. Huck, admitted that the surface tension relationship is met if the droplets do not contact channel walls. The parties do not dispute that this is the case for 10X's accused products. The jury also considered the testimony of Bio-Rad's expert, Dr. Sia, who presented testing evidence demonstrating that the claim limitation was met. Accordingly, we conclude that the district court properly denied 10X's motion for JMOL of non-infringement of the '083 patent and affirm the judgment of infringement of this patent.

B. Infringement of the '407 and '193 Patents

10X's non-infringement arguments regarding the '407 and '193 patents are based on its contention that the district court misconstrued the asserted claims of these patents. Specifically, 10X argues that, contrary to the district court's construction, the preambles of these patents' independent claims are limiting. We review claim construction de novo, reviewing subsidiary factual findings based on extrinsic evidence for clear error. *Teva Pharm. USA, Inc. v. Sandoz, Inc.*, 574 U.S. 318 (2015).

Whether a preamble is limiting is "determined on the facts of each case in light of the overall form of the claim, and the invention as described in the specification and illuminated in the prosecution history." *Applied Materials, Inc. v. Advanced Semiconductor Materials Am., Inc.*, 98 F.3d 1563, 1572–73 (Fed. Cir. 1996). A preamble limits the claimed invention if it recites essential structure or steps, or if it is "necessary to give life, meaning, and vitality" to the claim. *Pitney Bowes, Inc. v. Hewlett-Packard Co.*, 182 F.3d 1298, 1305 (Fed. Cir. 1999). If the claim uses the preamble only to state a purpose or intended use for the invention, then the preamble is not limiting. *Catalina Mktg. Int'l, Inc. v. Coolsavings.com, Inc.*, 289 F.3d 801, 808 (Fed. Cir. 2002). And, a preamble is generally not limiting unless there is "clear reliance on the preamble during prosecution to distinguish the claimed invention from the prior art." *Id.* Reliance on a preamble phrase for antecedent basis, however, may limit claim scope. *Bell Commc'ns Research, Inc. v. Vitalink Commc'ns Corp.*, 55 F.3d 615, 620 (Fed. Cir. 1995).

The preamble at issue recites "[a] method for conducting a reaction in plugs in a microfluidic system, comprising

the steps of . . . ." '407 patent, col. 78 ll. 54–55.[3] At the *Markman* stage, the district court found that the preamble was limiting "only to the extent that it provides an antecedent basis for the terms 'microfluidic system' and 'reaction.'" *Raindance Techs., Inc. v. 10X Genomics, Inc.*, No. 1:15-CV-00152-RGA, 2017 WL 382235, at *7 (D. Del. Jan. 26, 2017)). It found that the preamble at issue "states an intended use for the invention, 'followed by the body of the claim, in which the claim limitations describing the invention are recited.'" *Id.* (quoting *TomTom, Inc. v. Adolph*, 790 F.3d 1315, 1324 (Fed. Cir. 2015)). It also found that the invention, as claimed, was "'structurally complete' without the remaining preamble language." *Id.*

In its motion for JMOL, 10X argued that, under the correct claim construction, the preambles limit the claims to methods of conducting reactions inside a microfluidic system, *i.e.*, to "on-chip" reactions only. The district court rejected 10X's argument. It found that the preamble terms "reaction" and "microfluidic systems" provide antecedent basis for the use of those terms in the body of the claim, but that this does not necessarily convert the entire preamble into a limitation. *Bio-Rad*, 396 F. Supp. 3d at 380 ("While portions of a preamble may be limiting where those portions provide an antecedent basis for terms appearing in the body of the claim, it is inappropriate to construe an entire preamble as limiting if the rest of the preamble language is not limiting."). According to the district court, the italicized portion of the preamble "*conducting* a reaction in plugs *in* a microfluidic system" was not limiting because

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[3] The preamble of the claims of the '193 patent recite an "autocatalytic reaction" instead of a "reaction." '193 patent, col. 78 ll. 8–9. 10X states that the same arguments apply to the preambles of both the '407 and '193 patent claims and Bio-Rad offers no dispute on that point. Accordingly, our analysis applies to both patents.

this language does not "provide an antecedent basis for the rest of the claim and follows the standard pattern of a 'method for a purpose or intended use comprising,' followed by the body of the claim." *Id.* at 381 (citing *TomTom*, 790 F.3d at 1324).

On appeal, 10X again argues that the preamble term "reaction in plugs in a microfluidic system" is limiting. In 10X's view, the preamble requires the chemical reaction to take place in the droplets while the droplets are inside the microfluidic system, *i.e.*, the claimed methods are limited to "on-chip" reactions. By contrast, 10X argues, the reactions in its accused products are "off-chip" reactions—they are not completed until *after* a researcher removes the droplets from the microchannel and places them in a thermal cycler. Appellant's Br. 51–53.

10X argues that, as the district court found, the preamble clearly provides antecedent basis for the claim limitations "the microfluidic system" and "the reaction." It contends that, taken in conjunction with the specification and the prosecution history of the '407 patent, this establishes the drafter's intent to treat the entire preamble as limiting. Although we held in *TomTom* that it is possible for one part of the preamble to be limiting even though another portion is not, 10X asserts that *TomTom* does not apply where, as here, the preamble terms at issue were not distinct phrases. According to 10X, it was error to give limiting effect to certain terms in the preamble ("reaction" and "microfluidic system") but not to other terms surrounding those limiting parts ("conducting" and "in").

In Bio-Rad's view, the district court correctly found that the disputed language is a non-limiting statement of intended use or purpose. Bio-Rad also argues that, under *TomTom*, an entire preamble need not be limiting simply because it provides an antecedent basis in part. Bio-Rad further argues that 10X's non-enablement theory at trial

contradicts its arguments here. This time, we agree with 10X.

The district court's application of *TomTom* to the facts before it is erroneous. In *TomTom*, we held that the district court erred in determining that it had to construe the entire preamble if it construed a portion of it. *TomTom*, 790 F.3d at 1322–24. The two-part preamble of the asserted claim recited: "[1] [a] method for generating and updating data [2] for use in a destination tracking system of at least one mobile unit comprising . . . ." *Id.* at 1322 (alteration omitted). We held that the first part of the preamble, "method for generating and updating data," was not limiting and did not provide an antecedent basis for any claim terms. *Id.* at 1323–24. We also found that the term did not recite essential structure or steps, or give necessary life, meaning, and vitality to the claim; rather, it stated "a purpose or intended use." *Id.* At the same time, we held that the second part of the preamble, "destination tracking system of at least one mobile unit," was limiting because it provided antecedent basis for "the mobile unit" recited in the body of the claims. *Id.* Thus, we found that *TomTom* involved a partially-limiting preamble.

Crucially, unlike *TomTom*, the preamble in this case cannot be neatly packaged into two separate portions. Nor does it simply recite a method for an intended use or purpose. The district court held that the preamble terms "reaction" and "microfluidic systems" provide antecedent basis for the use of those terms in the body of the claim. We agree with the court on this point. But we disagree that these limiting terms can be read separately from the remainder of the preamble. The language relied upon for antecedent basis in the preamble at issue is intertwined with the rest of the preamble. The term "conducting" in the preamble is not analogous to the non-limiting language at issue in *TomTom*.

We also are disinclined to sanction finding a preamble "partially" limiting by splicing it as the district court did here. The fact that the terms "reaction" and "microfluidic systems" provide antecedent basis for these terms in the body of the claim is a strong indication that the preamble acts "as a necessary component of the claimed invention." *Eaton Corp. v. Rockwell Int'l Corp.*, 323 F.3d 1332, 1339 (Fed. Cir. 2003). Based on the antecedent relationship, it is clear the claim drafters intended to limit the claimed methods to on-chip reactions, using both the preamble and the body of the claim to define the claimed invention.[4] Accordingly, we conclude that the district court's claim construction is erroneous. Under the correct construction, the claimed methods are limited to on-chip reactions.

Bio-Rad argues that, even if the preamble is limiting, the jury's infringement verdict should be upheld. As a court of review, we refuse to decide, in the first instance, whether 10X's systems would infringe under the correct construction. Even Bio-Rad concedes that the district court precluded 10X from arguing that the entire preamble is limiting. Accordingly, we vacate the district court's judgment of infringement of the claims of the '407 and '193 patents and remand for a new trial on those issues.

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[4] The prosecution history of the patent, although not dispositive in this case, provides additional support for construing the claims as limited to reactions in a microfluidic system. During prosecution, the examiner amended both the preambles and the titles of the patents to specify that the reactions are conducted "in plugs in the microfluidic system." J.A. 8625–29; J.A. 8632.

C. DAMAGES

Despite vacating the district court's judgment of infringement of two of the patents-in-suit, we proceed with considering the parties' arguments concerning damages because we affirm the judgment of infringement of the '083 patent—which covers all six accused product lines. The jury verdict and jury instructions show that the damages award is not predicated on infringement of any one patent. J.A. 378 ("If you found that 10X Genomics infringed any of the asserted claims of the '083, '193, or '407 [p]atents . . . then with respect to that claim or those claims, please answer [the question on damages]."); J.A. 410 ("If you find that Plaintiffs have established infringement of a valid patent claim of the patents-in-suit, Plaintiffs will be entitled to a reasonable royalty to compensate them for that infringement."). As Bio-Rad explained during oral argument, affirming the judgment of infringement on the '083 patent—which includes the only asserted apparatus claims—would leave the damages award undisturbed. Oral Arg. at 21:18–44, *available at* http://oralarguments.cafc.uscourts.gov/default.aspx?fl=19-2255.mp3. 10X did not dispute this point either at oral argument or in its briefing to us. In fact, in its opening brief, 10X argued that reversal as to the '083 patent would affect the damages award, *see* Appellant's Br. 42, but did not make such an argument for the '407 and '193 patents.

The jury awarded almost $24 million in damages—the full requested amount based on a reasonable royalty rate of 15%. On appeal, 10X argues that the damages award should be vacated because Bio-Rad's expert relied on licenses that were not comparable to the hypothetical negotiation. 10X further argues that Bio-Rad's expert did not apportion damages to the value of the patented technology. As discussed below, we reject these arguments.

1. The District Court Did Not Abuse Its Discretion in Allowing the Jury to Consider Testimony Regarding the Three Licenses at Issue

At trial, the parties used the hypothetical negotiation or the "willing licensor-willing licensee" approach for calculating reasonable royalty damages. This approach attempts to calculate the royalty rate the parties would have agreed upon had they negotiated an agreement prior to the start of the infringement. In determining a reasonable royalty, parties frequently rely on comparable license agreements. *See Georgia–Pacific Corp. v. U.S. Plywood Corp.*, 318 F. Supp. 1116, 1120 (S.D.N.Y. 1970); *see also Radio Steel & Mfg. Co. v. MTD Prods., Inc.*, 788 F.2d 1554, 1557 (Fed. Cir. 1986) ("The determination of a reasonabl[e] royalty . . . is based . . . on the royalty to which a willing licensor and a willing licensee would have agreed at the time the infringement began."). Assessing the comparability of licenses requires a consideration of whether the license at issue involves comparable technology, is economically comparable, and arises under comparable circumstances as the hypothetical negotiation. *See generally LaserDynamics, Inc. v. Quanta Computer, Inc.*, 694 F.3d 51 (Fed. Cir. 2012).

We review the district court's decision to admit expert testimony for abuse of discretion. *Gen. Elec. Co. v. Joiner*, 522 U.S. 136, 146 (1997). The jury's determination of the amount of damages is an issue of fact, which we review for substantial evidence. *Lucent Techs., Inc. v. Gateway, Inc.*, 580 F.3d 1301, 1310 (Fed. Cir. 2009). A jury's damages award "must be upheld unless the amount is grossly excessive or monstrous, clearly not supported by the evidence, or based only on speculation or guesswork." *Id.* (internal quotation marks omitted).

At trial, Bio-Rad's damages expert, Mr. Malackowski, based his reasonable royalty calculation on three licenses that he deemed comparable: (1) the Caliper/RainDance license (2) the Applera/Bio-Rad license, and (3) the Applied

Bio/QuantaLife license. In its motion for JMOL, 10X argued that Mr. Malackowski's testimony was not sufficiently tied to the facts of the case because it was based on technologically noncomparable licenses. The district court agreed with 10X as to the Applera/Bio-Rad license, finding that Bio-Rad had failed to present sufficient evidence of the technological comparability of this license. But it nonetheless denied 10X's motion for JMOL because the other two licenses provided sufficient support for Mr. Malackowski's reasonable royalty opinions. *Bio-Rad*, 396 F. Supp. 3d at 386.

On appeal, 10X argues that Mr. Malackowski's expert opinion should be vacated because it was based on evidence that was "both inadmissible and insufficient." Appellant's Br. 54. 10X also provides extensive argument as to why each of the three licenses is not technologically comparable to the technology at issue in the hypothetical negotiation. *Id.* at 59–64.

This court has often excluded licenses that are technologically or economically non-comparable. *See, e.g.*, *LaserDynamics*, 694 F.3d at 77–78 ("The propriety of using prior settlement agreements to prove the amount of a reasonable royalty is questionable."); *ResQNet.com, Inc. v. Lansa, Inc.*, 594 F.3d 860, 873 (Fed. Cir. 2010) (district court erred by considering certain licenses and adjusting "upward" the reasonable royalty rate "without any factual findings that accounted for the technological and economic differences between those licenses"). The court has also held, however, that the issue of comparability is often one of sufficiency of the evidence, not admissibility. *Ericsson, Inc. v. D-Link Sys., Inc.*, 773 F.3d 1201, 1227 (Fed. Cir. 2014) ("[T]he fact that a license is not perfectly analogous generally goes to the weight of the evidence, not its admissibility."); *see also Finjan, Inc. v. Secure Computing Corp.,* 626 F.3d 1197, 1211 (Fed. Cir. 2010); *ActiveVideo Networks, Inc. v. Verizon Commc'ns, Inc.,* 694 F.3d 1312, 1333 (Fed. Cir. 2012). *Finjan*, for example, involved a license

which related to a lump sum payment rather than a running royalty. 626 F.3d at 1211–12. We affirmed a damages award because the "differences permitted the jury to properly discount [that license]." *Id.* at 1212. Likewise, in *ActiveVideo*, the damages expert relied on two agreements, one of which did not involve the patents or technologies in the case. 694 F.3d at 1333. We concluded that the district court did not abuse its discretion by failing to exclude the testimony of the damages expert because the "degree of comparability" of the license agreements is a "factual issue[] best addressed by cross examination and not by exclusion." *Id.*

Here, the district court concluded that Mr. Malackowski had met a showing of "baseline comparability" and that the "degree of comparability is a factual issue best addressed through cross examination." *Bio-Rad*, 396 F. Supp. 3d at 388. The Caliper/RainDance and Applied-Bio/QuantaLife licenses covered patents related to microfluids. The third license, Applera/Bio-Rad, dealt with thermal PCR cyclers—instruments that are used in biochemical reactions. The "degree of comparability" was appropriately left for the jury to decide. *See Active Video*, 694 F.3d at 1333. Accordingly, we see no abuse of discretion in allowing Mr. Malackowski to testify about these licenses.

We are also not persuaded by 10X's argument that, because the district court ultimately concluded that Bio-Rad had not presented sufficient evidence of comparability of the Applera/Bio-Rad agreement, the jury should never have heard testimony regarding this agreement. 10X contends that it is entitled to a new trial on this ground alone, unless it is "highly probable" that the error of admitting testimony about this license did not affect the jury's verdict. Appellant's Br. 58 (quoting *Hirst v. Inverness Hotel Corp.*, 544 F.3d 221, 228 (3d Cir. 2008)). We see several problems with 10X's argument.

Even assuming 10X sufficiently developed this argument in its opening appellate brief (which it did not), 10X does not challenge the jury instructions regarding the calculation of a reasonable royalty, which properly instructed the jury to account for any differences between the licenses. J.A. 415 ("[I]f you choose to rely upon evidence from any other license agreements, you must account for any differences between those licenses and the hypothetically negotiated license . . . in terms of the technologies and economic circumstances of the contracting parties."). The record also shows that 10X's *Daubert* motion regarding Mr. Malackowski's opinions was directed to his overall testimony, not to the exclusion of any one agreement. 10X also did not move the court during trial to exclude the specific agreement. 10X's arguments on this issue again conflate the question of admissibility with the question of degree of comparability of the licenses. On this record, we see no abuse of discretion in admitting Mr. Malackowski's testimony, even if the district court ultimately determined that Bio-Rad did not provide substantial evidence of technological comparability of one of the three licenses. Accordingly, we disagree with 10X that the jury should have never heard testimony regarding the Applera/Bio-Rad license, and reject its request for a new trial.

2. The Jury's Damages Award Is Supported by Substantial Evidence

10X also argues that no reasonable juror could find the three licenses comparable to the claimed invention. Instead of the three licenses relied upon by Mr. Malackowski, 10X contends that the University of Chicago/RainDance license is the most comparable license because it concerns the patents-in-suit. We are not persuaded.

The evidence at trial addressed each of the non-comparability arguments 10X is now raising on appeal. As to the University of Chicago/RainDance license, Mr. Malackowski opined that this license, from a university to a licensor

in the nascent period of the droplet technology, is not comparable to the hypothetical negotiation between two competitors in the context of a more developed field. He also explained that it was a non-competitive and exclusive license, further distinguishing it from the hypothetical negotiation. 10X then cross-examined Mr. Malackowski on this issue. The jury was free to accept this testimony and to reject the 1–3% royalty rate proposed by 10X based on the University of Chicago/RainDance agreement.

As to the comparability of the Caliper/RainDance license, 10X argues that the license is not comparable for several reasons: (1) it deals with consumables (reagents and chips) and not with expensive instruments; (2) the license involved 500+ patents relating to microfluids, not three patents dealing with specific droplet generation and manipulation; and (3) the 15% rate was "pure fiction" and never really actualized because RainDance and Caliper never competed in the licensed space. Appellant's Br. 62–63.

The evidence at trial was sufficient to show comparability of the Caliper/RainDance agreement. The jury heard the testimony of Bio-Rad's technical expert, Dr. Sia, who testified that the Caliper patents were comparable because they dealt with microfluids and the asserted patents also deal with the same subject matter, but specifically with droplets. Bio-Rad's corporate witness, Ms. Tumolo, also accounted for the difference in the number of patents in the Caliper/RainDance agreement and the hypothetical negotiation. According to Ms. Tumolo, the large number of Caliper patents in the Caliper/RainDance license were a necessary but very small part of the licensed RainDance portfolio; the main technology was the droplet technology, covered by the three patents-in-suit. Ms. Tumolo also addressed the 15% royalty rate, confirming that once RainDance directly competed with Caliper, the 15% royalty rate would apply. As to differentiating between licenses relating to consumables versus instruments, most of the

reasonable royalty damages at issue come from sales of consumables, not instruments. Accordingly, a reasonable juror could have concluded that the Caliper/RainDance license was comparable to the hypothetical negotiation, and substantial evidence supports the jury's verdict that a 15% reasonable royalty applies.

10X makes similar arguments regarding the AppliedBio/QuantaLife license. It argues that (1) the license does not require payments for instruments or even chips, and the 10–15% royalty rate for reagents cannot be directly translated to a royalty rate for expensive instruments; (2) the license focuses on a PCR enzyme that transformed the field; and (3) Mr. Malackowski did not address these differences. Appellant's Br. 60–61. We disagree.

The evidence at trial supports a finding of comparability for this agreement as well. For example, the jury considered the testimony of Dr. Sia, who explained that the license was comparable to the hypothetical negotiation because the AppliedBio license covered reagents that would enable a researcher to perform PCR in an improved manner, and the patents-in-suit also deal with performing improved PCR reactions using droplet technology. The jury also heard the testimony of Bio-Rad's corporate witness, Ms. Tumolo, who compared the two technologies and testified that the $0.12 per-unit royalty for the improved reagents in the AppliedBio agreement would translate to a much higher royalty rate per reaction in the hypothetical negotiation because one would use more quantities of the reagents in microfluidic systems. Accordingly, the evidence presented at trial regarding this agreement also supports the 15% reasonable royalty rate.[5]

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[5] Having concluded that substantial evidence supports the jury's verdict of a 15% royalty rate, we need not address the parties' arguments regarding the

Finally, we note that 10X's reliance on our decisions in *LaserDynamics* and *ResQNet* in support of its arguments is misplaced. In *LaserDynamics*, for example, the royalty rate proposed by the expert was "untethered from the patented technology at issue and the many licenses thereto." 694 F.3d at 81. Likewise, *ResQNet* involved a royalty award based entirely on inapposite licenses. 594 F.3d at 872. In both cases, the expert used licenses that served no purpose other than "to increase the reasonable royalty rate above rates more clearly linked to the economic demand for the claimed technology." *LaserDynamics*, 694 F.3d at 80. Here, by contrast, Mr. Malackowski evaluated the various licenses at issue and applied the *Georgia-Pacific* factors. He testified that it made sense to adopt a 15% reasonable royalty rate where the parties to the hypothetical negotiation are direct competitors. He also provided specific reasons why the University of Chicago/RainDance license was not comparable. Accordingly, we conclude that substantial evidence supports Mr. Malackowski's reasonable royalty opinions and the jury's verdict.

B. 10X's Apportionment Argument Is Without Merit

"When the accused technology does not make up the whole of the accused product, apportionment is required. The ultimate combination of royalty base and royalty rate must reflect the value attributable to the infringing features of the product, and no more." *Elbit Sys. Land & C4I Ltd. v. Hughes Network Sys., LLC*, 927 F.3d 1292, 1301 (Fed. Cir. 2019) (internal quotations and alterations omitted). "[A] reasonable royalty analysis necessarily involves

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comparability of the Applera/Bio-Rad license. As discussed above, we do not think the district court abused its discretion in allowing the jury to hear testimony regarding that license.

an element of approximation and uncertainty." *Lucent Techs.,* 580 F.3d at 1336 (internal quotations omitted).

10X challenges Mr. Malackowski's testimony because of his alleged failure to apportion damages between the patented and unpatented features of the accused products. In 10X's view, Mr. Malackowski claimed that his 15% royalty rate was already apportioned in the comparable licenses, but failed to provide any numerical value to support his analysis. 10X also argues that none of the other witnesses provided any testimony that could fill the gaps as to the technical contributions of any of the patents. We disagree.

As Bio-Rad correctly points out, there is no blanket rule of *quantitative* apportionment in every comparable license case. In *Elbit Systems Land & C4I Ltd. v. Hughes Network Systems, LLC*, for example, we accepted "built in apportionment" for a comparable license agreement. 927 F.3d at 1301 (internal quotations omitted). 10X argues that *Elbit* is distinguishable because the license at issue in that case was the "closest" comparator and the expert in *Elbit* actually made a quantitative adjustment to the comparator license. Appellant's Reply Br. 31. But this argument rests primarily on the faulty assumption that the Chicago/RainDance license (with the 1–3% royalty rate) is the most comparable license in this case. As discussed above, the jury was free to accept Bio-Rad's evidence that this license was not comparable.

Here, Mr. Malackowski concluded that no quantitative adjustment of the royalty rate in the three agreements was required. He explained that his methodology involved looking at comparable license agreements between competitors for similar technologies and assessing whether the importance of that technology to the particular license was similar to the hypothetical negotiation. He also acknowledged that he relied on the reports, testimony, and conclusions of other witnesses to understand that the licenses were technologically comparable, and that the proportion

of licensed/unlicensed features was comparable to the present case. Thus, under Mr. Malackowski's reasoning, no adjustment of the 15% royalty rate in the comparable licenses was required. His analysis could reasonably be found to incorporate the required apportionment. Our case law does not require more. *See, e.g.*, *VirnetX, Inc. v. Cisco Sys., Inc.*, 767 F.3d 1308, 1328 (Fed. Cir. 2014) ("[W]e note that we have never required absolute precision in [applying the principles of apportionment]; on the contrary, it is well-understood that this process may involve some degree of approximation and uncertainty."); *see also Ericsson, Inc.*, 773 F.3d at 1227 (recognizing that, even though "[p]rior licenses . . . are almost never perfectly analogous to the infringement action," if accompanied by testimony accounting for the distinguishing facts, prior licenses may help the jury decide an appropriate royalty award).

This is not a case in which an unsupported conclusory opinion leaves the jury with nothing but speculation. We thus agree with the district court that Mr. Malackowski's testimony was properly admitted. We therefore affirm the damages award.

D. INJUNCTION

"According to well-established principles of equity, a plaintiff seeking a permanent injunction must satisfy a four-factor test before a court may grant such relief." *eBay Inc. v. MercExchange, LLC*, 547 U.S. 388, 391 (2006). "A plaintiff must demonstrate: (1) that it has suffered an irreparable injury; (2) that remedies available at law, such as monetary damages, are inadequate to compensate for that injury; (3) that, considering the balance of hardships between the plaintiff and defendant, a remedy in equity is warranted; and (4) that the public interest would not be disserved by a permanent injunction." *Id.* The district court's grant of an injunction is reviewed for abuse of discretion. *eBay Inc.*, 547 U.S. at 391. We review the district court's conclusion as to each *eBay* factor for abuse of

discretion and its underlying factual findings for clear error. *i4i Ltd. P'ship v. Microsoft Corp.*, 598 F.3d 831, 861 (Fed. Cir. 2010), *aff'd*, 564 U.S. 91 (2011). Only the first, third, and fourth factors are at issue on appeal.

The district court found that Bio-Rad satisfied all four *eBay* factors. On appeal, 10X argues that Bio-Rad failed to justify its request for a permanent injunction because it did not show irreparable harm, and because neither the balance of hardships nor the public interest support an injunction. We address these arguments below.

1. Irreparable Harm

To prove irreparable injury, a patentee must show "that absent an injunction, it will suffer irreparable harm, and . . . that a sufficiently strong causal nexus relates the alleged harm to the alleged infringement." *Apple Inc. v. Samsung Elecs. Co.*, 695 F.3d 1370, 1374 (Fed. Cir. 2012).

The district court found that 10X and Bio-Rad are direct competitors, and Bio-Rad would suffer irreparable competitive harm absent an injunction. 10X argues, however, that it was improper for the court to enjoin sales in the name of competition because 10X and Bio-Rad do not directly compete. 10X states that it is undisputed that Bio-Rad did not even claim to compete with four out of five of 10X's product lines. According to 10X, only one product line, 10X's Single Cell 3', potentially competes with Bio-Rad ddSEQ product. Even as to this product, however, 10X argues that there is no irreparable harm because Bio-Rad's product is inferior, faces competition from at least ten other competitors, and Bio-Rad could not prove that it lost a single sale to 10X. Thus, in 10X's view an injunction is unlikely to help Bio-Rad's competitive position. Appellant's Br. 73–74.

Bio-Rad responds that 10X admitted that the Single Cell 3' product, *which accounts for over 80% of 10X's revenue*, competes directly with Bio-Rad's ddSEQ product. Bio-

Rad also contends that 10X's allegations of commercially and technically superior products support Bio-Rad's claim of irreparable harm. Bio-Rad explains that it was forced to market early in view of the head start 10X received from its willful infringement. Bio-Rad also explains that it "fell behind 10X in the droplet field because the 10X founders left Bio-Rad to start 10X with much of Bio-Rad's droplet expertise and hired away even more droplet-experienced technologists." Appellees' Br. 58–59. In Bio-Rad's view, the first mover advantage allowed 10X to capture many "sticky" customer relationships and secure a competitive lead. Finally, Bio-Rad contends that 10X's argument that Bio-Rad did not lose any customers is inconsistent with the fact that the two company's products are sold "head to head." *Id.* at 57–61.

It is undeniable that Bio-Rad has suffered harm from 10X's first mover advantage and "sticky" customer relationships. The district court found that Bio-Rad is being forced to compete with 10X's products that incorporate the infringing technology. Based on its willful infringement—a finding 10X does not challenge on appeal—10X has established a strong market lead over Bio-Rad. The court also found that, based on 10X's first mover advantage, Bio-Rad had to increase its marketing costs. Money damages will not be able to compensate Bio-Rad for the harms stemming from 10X's first mover advantage.

2. Balance of Hardships

In considering the balance of hardships, courts may consider the "parties' sizes, products, and revenue sources." *i4i Ltd. P'ship*, 598 F.3d at 862. "[E]xpenses . . . incurred in creating the infringing products" and "the consequences . . . of its infringement, such as the cost of redesigning the infringing products" are "irrelevant." *Id.* at 863.

The district court found that the balance of hardships weighed in favor of injunctive relief or, at minimum, was

neutral. The court found that Bio-Rad's hardship stems from the fact that it significantly invested in its droplet business. And the court found that 10X's hardship is mitigated because it could sell its new, non-infringing products. On appeal, 10X argues that the district court failed to consider that it does not have a new design for two of its product lines. 10X explains that it is a much smaller company than Bio-Rad and its entire business depends on the enjoined products.

Bio-Rad contends that 10X's argument that 10X does not have a new design for two of its product lines (Linked-Reads and CNV) is undermined by the fact that 10X's Linked-Reads and CNV products are trivial to its economics. Bio-Rad also points out that the district court gave 10X a fair amount of time to design around the patents-in-suit. We do not agree.

We acknowledge that Bio-Rad, although a much larger company, will suffer considerable hardship absent an injunction because it has invested almost half a billion dollars to develop its products, including acquisitions and tens of millions of dollars a year on research and development. But at the same time, 10X, a much smaller company, depends entirely on the sales of the enjoined products for its revenue. Although the district court concluded that the hardship to 10X is mitigated because it can sell its non-infringing alternatives, the district court failed to consider the lack of non-infringing products for two out of the five product lines. In the absence of non-infringing alternatives for the Linked-Reads and CNV products, we conclude it was an abuse of discretion for the district court to enjoin sales of these two product lines.

3. Public Interest

"[T]he touchstone of the public interest factor is whether an injunction, both in scope and effect, strikes a workable balance between protecting the patentee's rights

and protecting the public from the injunction's adverse effects." *i4i*, 598 F.3d at 863.

The district court carved out an exception for infringing products that were sold or in use before the effective date of the injunction (the "Historical Installed Base"). For these products, 10X can also continue to supply consumables, and support, service, repair, and replace them under warranty. This exception is conditional on 10X paying a 15% royalty on the net revenue 10X receives from the permitted Historical Installed Base sales until the expiration of the patents-in-suit. Despite this carve-out, 10X argues that the undisputed evidence demonstrates that scientists need 10X products to do important research, which weighs against injunctive relief. Appellant's Br. 78–79.

We see no abuse of discretion here. Under the district court's injunction, 10X's existing customers are not enjoined from using their installed systems, as long as 10X pays royalties. Thus, there is no basis for 10X's argument that scientists will lose their years of research or be financially precluded from working on existing projects. On-going research projects will not be affected, and the scientist statements submitted by the amicus all presuppose that they will be required to give up their existing equipment. None of the letter writers, moreover, seem to be aware of 10X's replacement non-infringing design that supposedly works just as well as the Historically Installed Base.

The district court carefully crafted an injunction that allows existing 10X customers to continue their important research but attempts to mitigate the harm to Bio-Rad from 10X's first mover advantage. The court also provided 10X with an opportunity to design non-infringing alternatives, which 10X has done for all but two infringing product lines. In these circumstances, we conclude that the district court did not abuse its discretion in granting Bio-Rad an injunction, except as to the Linked-Reads and CNV product lines. Accordingly, we vacate the injunction as to those two

product lines only, but conclude that the injunction should remain in place as to the other enjoined product lines.

CONCLUSION

We have considered the parties' remaining arguments and find them unpersuasive. For the foregoing reasons, we affirm-in-part, reverse-in-part, and vacate-in-part the district court's decision denying 10X's motion for JMOL. We vacate the district court's injunction only with respect to 10X's Linked-Reads and CNV product lines.

AFFIRMED-IN-PART, REVERSED-IN-PART, VACATED-IN-PART, AND REMANDED

COSTS

No costs.