

2022-1539, 2022-1540, 2022-1541, 2022-1542

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UNITED STATES COURT OF APPEALS FOR THE FEDERAL CIRCUIT

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SAMSUNG ELECTRONICS CO., LTD.,

*Appellant*

v.

ACORN SEMI, LLC,

*Appellee*

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Appeal from the United States Patent and Trademark Office,  
Patent Trial and Appeal Board in Case Nos.  
IPR2020-01206, IPR2020-01207, IPR2020-01279, and IPR2020-01282

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**ACORN'S CORRECTED APPELLEE BRIEF**

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## REPRESENTATIVE CLAIMS

### U.S. PATENT NO. 9,905,691

1. A structure, comprising
  - a semiconductor region in a substrate,
  - a metal electrical contact to said semiconductor region,
  - a metal oxide layer, and a passivating dielectric tunnel barrier layer between said semiconductor region and said metal electrical contact,
  - said semiconductor region being electrically connected to said metal electrical contact through said passivating dielectric tunnel barrier layer and said metal oxide layer,
  - wherein said passivating dielectric tunnel barrier layer comprises a semiconductor oxide.
3. The structure of claim 1, wherein the semiconductor oxide of the dielectric tunnel barrier layer has a thickness of approximately 0.1 nm to 5 nm.
6. The structure of claim 3, wherein the metal oxide layer comprises an oxide of titanium.
8. The structure of claim 6, wherein the semiconductor region comprises an n-type doped source or drain of a transistor.
19. The structure of claim 1, wherein the semiconductor region comprises silicon, the semiconductor oxide comprises an oxide of silicon, the metal oxide layer comprises an oxide of titanium, and the metal electrical contact comprises titanium.

U.S. PATENT NO. 10,090,395

1. An electrical junction, comprising
  - a region in a semiconductor substrate,
  - a metal electrical contact to said region, and
  - an interface layer between said region and said metal electrical contact, said region being electrically connected to said metal electrical contact through said interface layer and said interface layer comprising a metal oxide and a semiconductor oxide, and being in contact with said region in the semiconductor substrate and said metal electrical contact.
11. The electrical junction of claim 1, wherein said metal oxide comprises an oxide of titanium.
12. The electrical junction of claim 11, wherein said semiconductor oxide comprises an oxide of silicon.
14. The electrical junction of claim 12, wherein said region in the semiconductor substrate comprises an n-type doped source or drain of a transistor.
17. An electrical junction, comprising:
  - a source or drain of a transistor, said source or drain comprising a semiconductor,
  - a metal electrical contact to said source or drain, and
  - an interface layer disposed between and in contact with said source or drain and said metal electrical contact, said source or drain being electrically connected to said metal electrical contact through said interface layer and said interface layer comprising an oxide of titanium and an oxide of the semiconductor.
23. A semiconductor device, comprising:
  - a semiconductor region,
  - a metal electrical contact to said semiconductor region, and
  - an interface layer disposed between and in contact with said semiconductor region and said metal electrical contact, said semiconductor region being electrically connected to said metal electrical contact through said interface layer and said interface layer comprising an oxide of titanium and an oxide of the semiconductor region.

**UNITED STATES COURT OF APPEALS  
FOR THE FEDERAL CIRCUIT**

**CERTIFICATE OF INTEREST**

**Case Number** 2022-1539, 2022-1540, 2022-1541, 2022-1542  
**Short Case Caption** Samsung Electronics Co., Ltd. v. Acorn Semi, LLC  
**Filing Party/Entity** Acorn Semi, LLC

**Instructions:** Complete each section of the form. In answering items 2 and 3, be specific as to which represented entities the answers apply; lack of specificity may result in non-compliance. **Please enter only one item per box; attach additional pages as needed and check the relevant box.** Counsel must immediately file an amended Certificate of Interest if information changes. Fed. Cir. R. 47.4(b).

I certify the following information and any attached sheets are accurate and complete to the best of my knowledge.

Date: 10/11/2022

Signature: /s/ M.C. Phillips

Name: Matthew C. Phillips

<p><b>1. Represented Entities.</b> Fed. Cir. R. 47.4(a)(1).</p>	<p><b>2. Real Party in Interest.</b> Fed. Cir. R. 47.4(a)(2).</p>	<p><b>3. Parent Corporations and Stockholders.</b> Fed. Cir. R. 47.4(a)(3).</p>
<p>Provide the full names of all entities represented by undersigned counsel in this case.</p>	<p>Provide the full names of all real parties in interest for the entities. Do not list the real parties if they are the same as the entities.</p> <p><input checked="" type="checkbox"/> None/Not Applicable</p>	<p>Provide the full names of all parent corporations for the entities and all publicly held companies that own 10% or more stock in the entities.</p> <p><input type="checkbox"/> None/Not Applicable</p>
<p>Acorn Semi, LLC</p>		<p>Acorn Techs., Inc.</p>

Additional pages attached

**4. Legal Representatives.** List all law firms, partners, and associates that (a) appeared for the entities in the originating court or agency or (b) are expected to appear in this court for the entities. Do not include those who have already entered an appearance in this court. Fed. Cir. R. 47.4(a)(4).

None/Not Applicable  Additional pages attached

Rachel Slade, Laurence & Phillips IP Law		

**5. Related Cases.** Provide the case titles and numbers of any case known to be pending in this court or any other court or agency that will directly affect or be directly affected by this court's decision in the pending appeal. Do not include the originating case number(s) for this case. Fed. Cir. R. 47.4(a)(5). See also Fed. Cir. R. 47.5(b).

None/Not Applicable  Additional pages attached

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**6. Organizational Victims and Bankruptcy Cases.** Provide any information required under Fed. R. App. P. 26.1(b) (organizational victims in criminal cases) and 26.1(c) (bankruptcy case debtors and trustees). Fed. Cir. R. 47.4(a)(6).

None/Not Applicable  Additional pages attached


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## STATEMENT OF RELATED CASES

Acorn Semi, LLC (“Acorn”) is unaware of any other appeals in or from the same proceedings as these matters previously before this or any other appellate court.

U.S. Patent Nos. 9,905,691 (Appx00237-00257) and 10,090,395 (Appx00258-00277), the patents that are the subject of the *inter partes* reviews (IPRs) on appeal in these cases, were asserted by Acorn against Samsung Electronics Co., Ltd. (“Samsung”) in the following infringement litigation: *Acorn Semi, LLC v. Samsung Elecs. Co.*, No. 2:19-cv-00347-JRG (E.D. Tex. filed Oct. 23, 2019), which resulted in a jury verdict of infringement by Samsung of eight claims (all claims Acorn asserted in trial). *See* Appx07886-07893. That district court case is on appeal in this court as companion case no. 2022-1499 (herein “2022-1499” or “Companion Case”).

## I. JURISDICTIONAL STATEMENT

Acorn agrees that the Board's final written decisions (FWDs) are appealable, this Court has jurisdiction, and Samsung has standing to bring these appeals.

## II. STATEMENT OF ISSUES

1. Does substantial evidence support the Board's finding that Samsung failed to prove that combining the teachings of Goodnick and Taubenblatt would lower resistance?

2. Does substantial evidence support the Board's finding that Kim does not suggest combining the teachings of Goodnick and Taubenblatt to lower resistance?

3. Does substantial evidence support the Board's finding that Kim taught away from the Goodnick-Taubenblatt combination Samsung proposed?

4. Did the Board abuse its discretion by not entertaining Samsung's new reply arguments against the Oxide-of-Titanium Claims (claims 6, 8, 10-12, 15-19, and 26-29 of the '691 Patent and claims 11, 12, and 14 of the '395 Patent – what Samsung calls the “Comprises Claims”)?

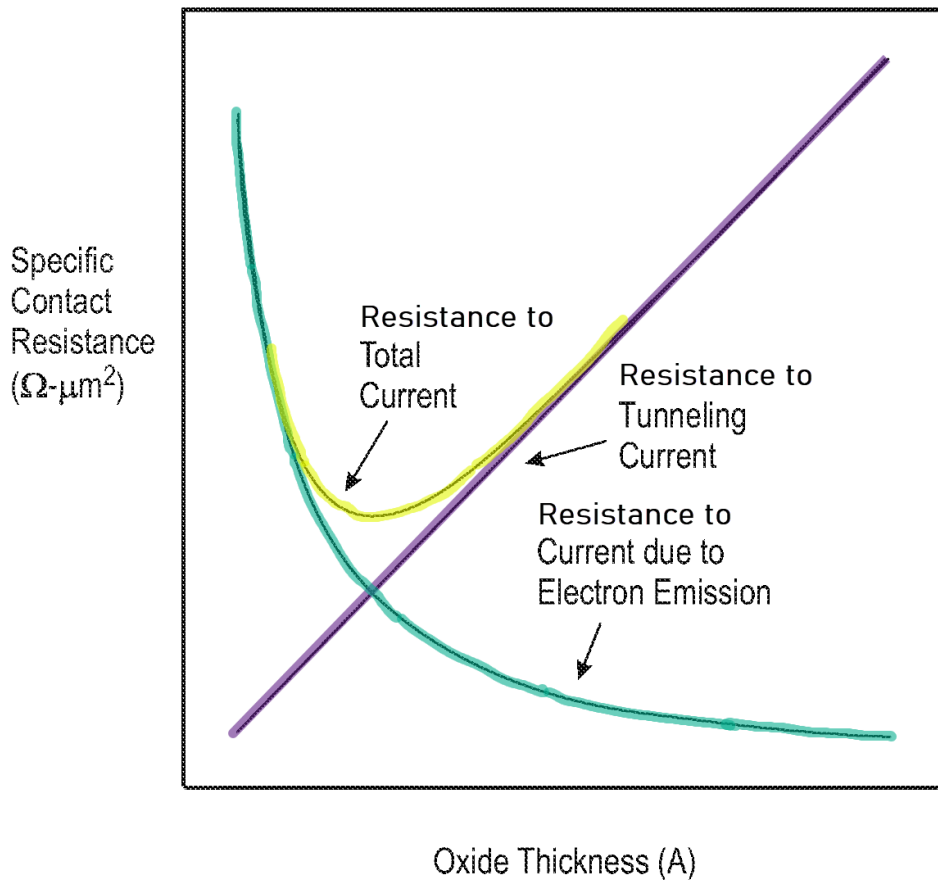
### III. STATEMENT OF CASE AND FACTS

#### A. Acorn's Invention

Prior to the Acorn invention by Dr. Daniel Grupp and Dr. Daniel Connelly in 2001, the conventional approach to minimize resistance at a metal-semiconductor (MS) junction was either to have direct contact or to interpose between the metal and semiconductor a highly conductive silicide of the metal. *See* Appx07524-07533; Appx21998-22003. While metal-insulator-semiconductor (MIS) junctions were known and used for other purposes, and some had observed that an insulator could sometimes reduce resistance, that phenomenon was not well understood prior to the work of the Acorn inventors. *See* Appx00887-00888. Indeed, great effort was expended to try to **remove** intermediate oxides and other insulators that might interfere with the MS junction. MIS junctions certainly were not used where a low-resistance MS junction was desired. *See, e.g.*, Appx03385 1:7-18; Appx03386 4:11-25.

The Acorn inventors were the first to realize that satisfactorily depinning the Fermi level at an MS junction requires both passivation and MIGS (metal-induced gap states) reduction. *See* Appx22001-22002. With that understanding,

they figured out how to engineer an interface layer that would minimize resistance. See Appx07526-07527. Figure 8 (below, annotated) of the Acorn patents illustrates the optimization problem (and solution) that the Acorn inventors discovered. *Id.* That graph, and the new insights that it encapsulates, provided a roadmap for semiconductor device designers to create MIS junctions with minimum resistance. *Id.*



Apx00889.

Figure 8 illustrates three curves of resistance across an MIS junction as a function of the interface layer thickness: Two component curves and one sum total curve. *See* Appx00253 14:29-52.<sup>1</sup> The first component (highlighted purple) represents the phenomenon that resistance to quantum tunneling increases as the thickness of the interface layer increases. *See id.* The second component (highlighted green) represents the effect of MIGS, as a thicker interface layer further separates the metal from the semiconductor and thereby decreases MIGS. *See id.* The third curve (a section of which is highlighted yellow) is the sum of the other two curves, representing resistance to total current. *See id.* As can be seen, there is a minimum on the total curve, which corresponds to the ideal interface layer thickness – a “Goldilocks” thickness that is not too thin such that MIGS unduly pin the Fermi level and not too thick such that tunneling is hampered. Appx00890; Appx08385; Appx16712; Appx23631.

After proving the concept of their invention with available materials and processes, the Acorn inventors published two papers disclosing their invention.

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<sup>1</sup> The Acorn patents in all IPRs below have essentially the same specification. Specification citations in this brief are to the '691 Patent only.

*See* Appx22050-22059; *see also* Appx22585-22589. Those have become seminal papers, cited hundreds of times. *See* Appx22611.

Many observers recognized the innovation of this work. *See, e.g.*, Appx22933-22934 (recognizing Acorn as “first propos[ing] and demonstrat[ing] unpinning of the silicon Fermi level by inserting an ultrathin insulator between the metal and semiconductor”); Appx22074-22077 (recognizing Acorn as “first” “to mitigate Fermi level pinning and reduce the contact resistance by inserting [an] interfacial layer between metal and semiconductor”); Appx22925-22932 (describing Acorn’s work as a “glimpse of the theoretical potential of this paradigm”); Appx22595-22597. Others characterized the invention as “counter-intuitive.” *E.g.*, Appx22760, Appx22773; Appx22779-22780; Appx07525-07526.

The excitement was understandable. An MS (or MIS) junction with reduced resistance has important benefits, including: (1) enabling smaller junctions and therefore smaller transistors, meaning that more transistors can be placed on a chip, (2) reduced power consumption, and (3) faster switching. *See* Appx22627-22630; *see also* Appx16381 (admitting less interface-layer resistance would “reduce the power consumption of a device incorporating a contact with

that interface layer”); Appx19174-19175 (same); Appx23309 (same); Appx26946-26947; Appx22780 (explaining less contact resistance “primarily translates into power reduction for performance-challenged designs”); Appx05713 2:9-10 (explaining that increased resistance slows MOSFET switching speed); Appx07527-07528 (noting link between resistance and speed, power consumption, and transistor density); Appx19365 1:38-41. Those benefits are magnified by the fact that every modern transistor has two MS junctions, and modern microprocessors contain billions of transistors. Processors with more, faster transistors that consume less power were (and are) a big deal.

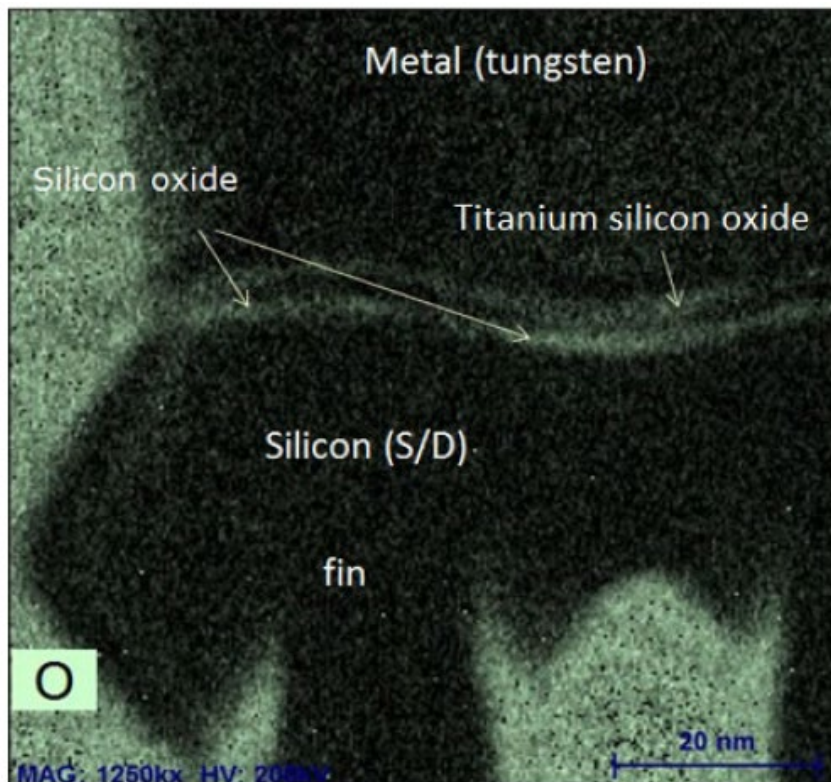
The Acorn inventors had the additional insight that the interface layer could be two separate layers – one, next to the semiconductor, to passivate it and one, next to the metal, to provide the necessary MIGS mitigation – that is, a passivation layer and a spacer/separation layer. *See* Appx00248 3:47-50; Appx00251 9:49-62; Appx22002; Appx07525; Appx07555.

Acorn filed its first patent application for this invention in 2002 and eventually obtained several patents, including the '691 and '395 Patents, both of

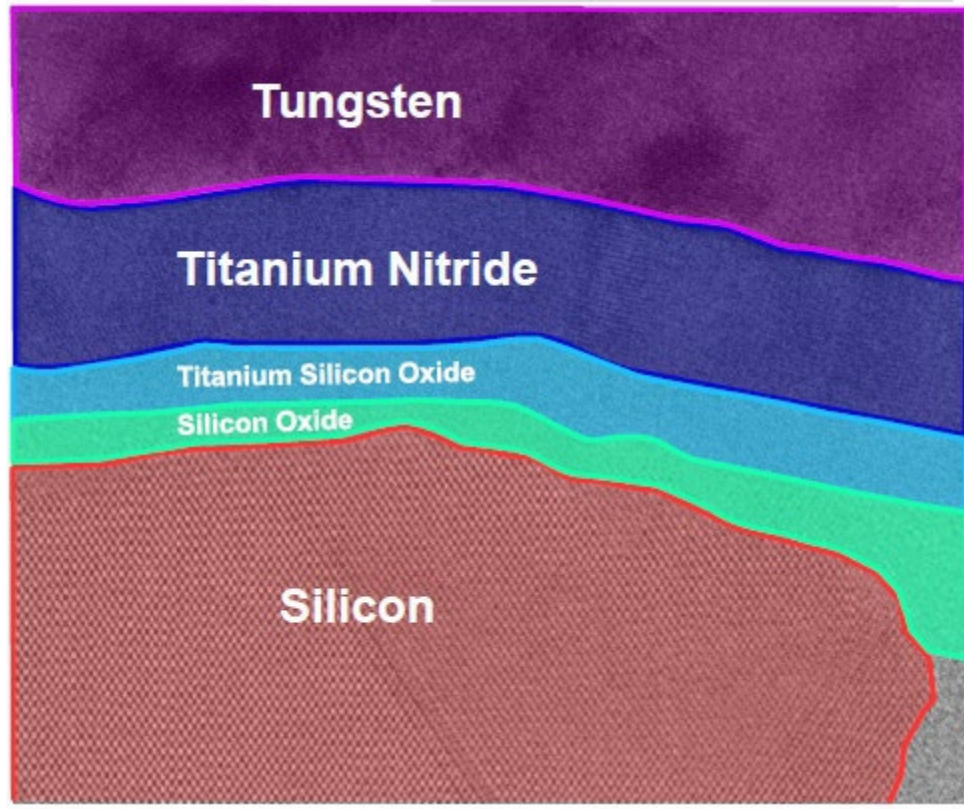
which include claims requiring a two-layer interface – a semiconductor-oxide passivating layer and a titanium-oxide spacer layer.

## B. Related Litigation

In 2019, Acorn sued Samsung, asserting infringement of six patents in this family. The accused products include, for example, Samsung's Exynos-brand processor in Galaxy-brand smartphones. The following microscope image shows one of the billions of junctions in such processors:



Appx19951. This structure is similarly illustrated in the Companion Case as follows:



2022-1499, Dkt. 16 at 3 (Fed. Cir. June 21, 2022).

Due to time constraints, Acorn had to narrow its contentions for trial to eight claims in four different patents, including claims 6, 8, and 19 of the '691 Patent and claims 17 and 20 of the '395 Patent – the two patents that are the subjects of these appeals. The jury found that Samsung had infringed every claim in trial and awarded damages of \$25 million. *See* Appx07889-07891.

Samsung initially raised the same or similar invalidity challenges in the district court as in its IPR petition. *See* Appx21937-21939; Appx21889;

Appx21920; Appx21932. However, after Acorn asked the Board to discretionarily deny the petitions because of the overlap, Appx00694-00713; Appx08196-08216; Appx16482-16500; Appx23410-23428, Samsung stipulated not to raise prior-art-based invalidity arguments in the district court, Appx00782-00786; Appx08280-08284; Appx16582-16586; Appx23504-23508. But Samsung did not stipulate to drop the same § 112 invalidity arguments underlying its priority-disentitlement challenges in the IPRs. *See id.* Then, after Acorn argued that the court's decision on the § 112 invalidity arguments would estop Samsung from maintaining its priority-disentitlement challenges in the IPRs, *see* Appx00916-00921, Appx00934-00935, Appx08410-08416, Appx08428-08429, Samsung dropped its § 112 invalidity arguments in the district court, Appx01003 n. 9, Appx08497 (same).

### C. IPR Petitions

Samsung filed ten IPR petitions against the six asserted Acorn patents. The petitions presented two types of challenges: (1) benefit-disentitlement challenges asserting Acorn's own "Grupp '483 Patent" as prior art based on arguments that the challenged claims were not entitled to the benefit of an earlier filing date

under § 112 and (2) traditional prior-art challenges, most of which were based on one or more of five references, three of which (Goodnick, Taubenblatt, and Kim) are introduced below.

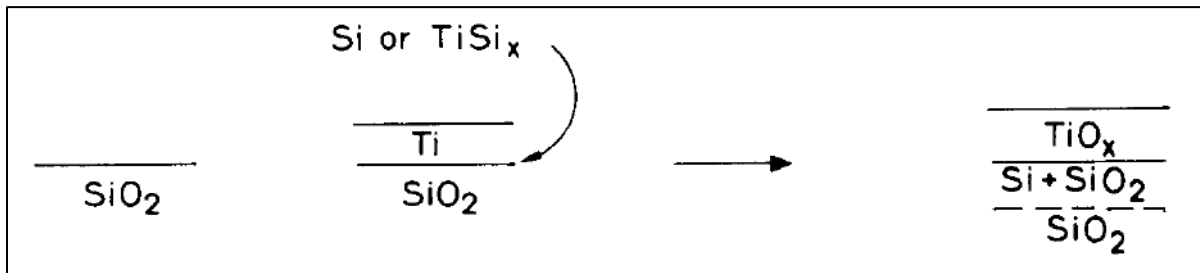
### 1. Goodnick

Goodnick (Appx03349-03355) is a 1981 article in the Journal of Vacuum Science and Technology that presents experimental results of research into the effects of a layer of silicon dioxide ( $\text{SiO}_2$ ) between silicon and three metals (aluminum, platinum, and gold). In the case of aluminum, evidence of aluminum oxide and silicon was found in the interface region. Appx03354.

As explained by Acorn's expert, Dr. Kelin Kuhn, a renowned former Intel fellow, Goodnick is one of many "physics studies where people put everything on everything and measure everything." Appx03930; *see also* Appx03822 ("[T]here's a broad community of surface scientists who publish material X on material Y on material Z papers who are not thinking of its application in a transistor source/drain, for example."); Appx03793 (same), Appx03932 (same).

## 2. Taubenblatt

Taubenblatt<sup>2</sup> (Appx04548-04556) is another one of those “physics studies,” published in 1982 in the Journal of Applied Physics. Taubenblatt reports the results of several experiments depositing titanium on silicon under various conditions. In one case, a “thick” layer of SiO<sub>2</sub> has formed on the silicon (so thick that the underlying silicon can be ignored) before depositing titanium. Appx04554-04556. The results in that case are reported as follows:



Appx04555.

## 3. Kim

Kim (Appx03382-03387) relates to direct metal contacts to silicon. Kim’s background section teaches the conventional approach of removing native oxides from silicon, *see* Appx03385 1:12-30, and having a silicide layer between the

<sup>2</sup> Sometimes referred to below as “Taubenblatt 1982” in distinction from “Taubenblatt 1984,” another paper by the same lead author.

silicon and the metal, *see id.* 1:31-41. For the contact metal, Kim teaches against using aluminum (because it penetrates into silicon and tends to migrate) and titanium (because of thermal mismatch to silicon) and instead teaches using a tungsten-titanium alloy:

A major impediment in the fabrication of low resistivity ohmic contacts to silicon is the presence of a thin layer of native oxide on the surface of the silicon. Accordingly, it is advantageous to use metals that are capable of reacting with the native oxide during the sintering or bonding step thereby removing the native oxide from the metal-silicon interface. Aluminum is a good reducing agent of [SiO<sub>2</sub>]. Aluminum, however, in direct contact with silicon penetrates readily into the silicon during the sintering step and would short circuit any underlying shallow junction. Also, aluminum has a tendency to migrate. Titanium is also a good agent for reducing [SiO<sub>2</sub>]. Pure titanium, however, is not suitable for contacts as direct contact between titanium and silicon has shown poor reproducibility due to the large difference in the linear thermal coefficient of expansions of titanium and silicon (the linear coefficient of expansion of titanium being three times the linear coefficient of expansion of silicon).

Alloys of tungsten and titanium have been found to be effective ...

*Id.* 1:12-32.

Kim therefore proposes as a contact metal “an alloy of 10% titanium and the remainder tungsten by weight.” Appx03386 4:59-60. This is illustrated by reference number 27 and “Ti-W” in Figure 3C (reproduced below with Figure 3B with color enhancement to show the titanium-tungsten (“Ti-W”) alloy 27 in red; silicon, including doped conductive silicon regions 15-17 in blue; and SiO<sub>2</sub> in yellow).

FIG. 3B

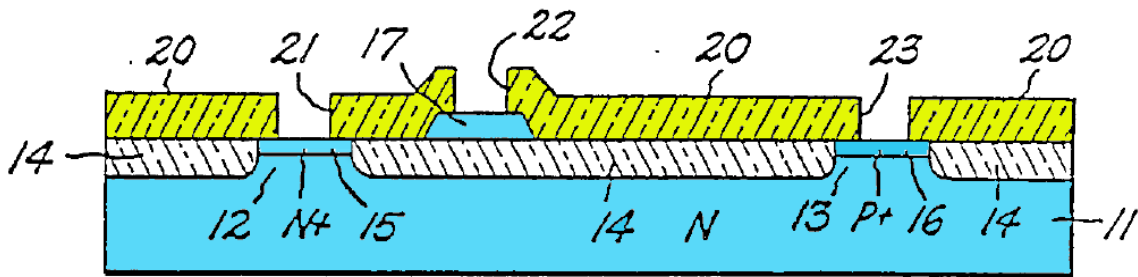
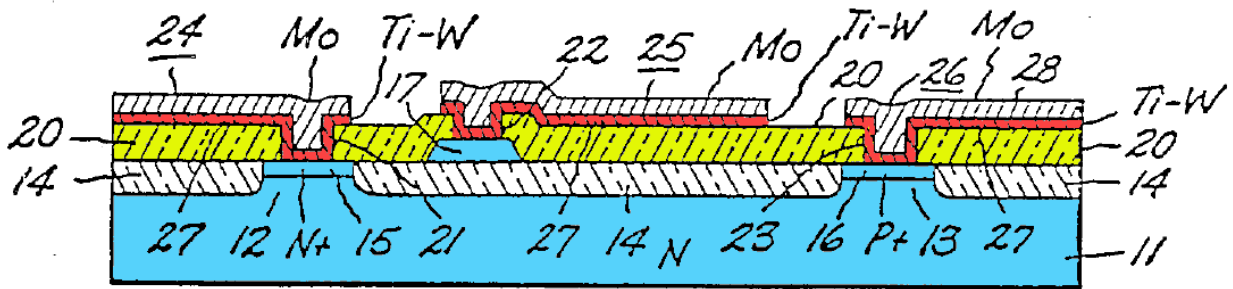


FIG. 3C



Kim speculates that resistance might be reduced by the creation of titanium dioxide ( $\text{TiO}_2$ ) when the Ti-W alloy (red) is added and titanium therein reacts with  $\text{SiO}_2$  (yellow):

The first conductor 27 of an alloy of 10% titanium and the remainder tungsten by weight forms a stable low resistance ohmic contact to the silicon conductive members 15,17 and 16, and also forms a strong bond to the thick layer 20 of  $[\text{SiO}_2]$ . It is *believed* that during the sintering step titanium in the conductor 27 at the interface between the conductor 27 and the silicon conductive members 15, 17 and 16 reacts with native  $[\text{SiO}_2]$  present on the exposed portions of these conductors to form silicon and  $[\text{TiO}_2]$ , a semiconductor, thereby reducing the interface resistance.

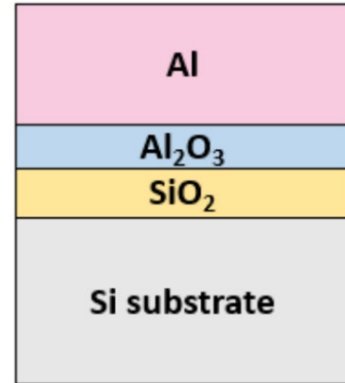
Appx03386-03387 4:59–5:1 (emphasis added).

#### 4. Goodnick-Taubenblatt-based § 103 challenges

Every petition relying on at least Goodnick and Taubenblatt (including the IPR2020-01279 and IPR2020-01282 petitions on appeal) proposed the same combination of those two references, supported by the same alleged motivation – “the ‘how’” and “the ‘why’” of the Goodnick-Taubenblatt combination in the words of the petition. This was the base combination on which other references were added to allegedly reach some claims. The petitions’ case was supported by

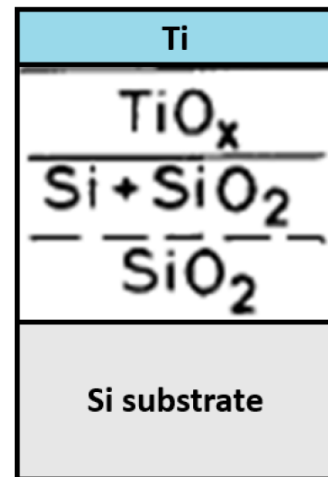
testimony from Samsung’s hired expert, Dr. Schubert, who provided essentially identical testimony regarding this combination in all cases.

The petitions first asserted that the aluminum example in Goodnick resulted in a stratification of distinct interface layers of aluminum oxide ( $\text{Al}_2\text{O}_3$ ) and  $\text{SiO}_2$  that the petitions illustrated as shown on the right. Appx16364; Appx19145; Appx23287; Appx26889-26890.



Next, the petitions asserted that it would have been obvious to a person of ordinary skill in the art (POSITA) to instead have placed titanium – rather than aluminum – on the silicon substrate, as allegedly suggested by one of Taubenblatt’s experiments (in which titanium is placed on a “thick” layer of  $\text{SiO}_2$  atop silicon). Appx16375-16382; Appx19164-19175; Appx23303-23309; Appx26936-26947.

The result of that modification, according to the petitions, would have been the structure shown on the right. The petitions presented this as “how” a POSITA would have allegedly combined the teachings of Goodnick and Taubenblatt. Appx16376-16378; Appx19165-19168; Appx23304-23306; Appx26937-26940.



The petitions then asserted that the motivation to modify Goodnick in light of Taubenblatt in this way was to decrease the resistance of the junction. This was the alleged “why” according to the petitions. Appx16378-16382; Appx19168-19175; Appx23306-23309; Appx26940-26947. In particular, the petitions claimed this would reduce resistance in two ways – the “best of both worlds” according to the petitions: (1) having some SiO<sub>2</sub> passivate the silicon thereby lowering the barrier height and (2) generating some TiO<sub>2</sub>, which has lower resistance than Al<sub>2</sub>O<sub>3</sub>. Appx16381; Appx19172-19173; Appx23308; Appx26944-26945. Those were the only theories in the petitions for the alleged reduction in resistance.

The petitions advanced those two theories despite (1) occurring the same in both stacks (Goodnick alone and the Goodnick-Taubenblatt combination), therefore not favoring one over the other in terms of resistance and despite the bulk resistances of TiO<sub>2</sub> and Al<sub>2</sub>O<sub>3</sub> being largely immaterial through those extremely thin interface layers, as the dominant current mechanism is quantum tunnelling. *See* Samsung Br. at 29-30.

Central to the petitions' reduced-resistance reasoning was an assertion that what Taubenblatt labels as "TiO<sub>x</sub>" (unspecified oxide of titanium) would be TiO<sub>2</sub> because that is the particular oxide of titanium that "presents less resistance than aluminum oxide." Appx16381; Appx19173; Appx23308; Appx26945. The petition justified this assertion with the claim that TiO<sub>2</sub> is "the oxide of titanium most likely to form when titanium reacts with [SiO<sub>2</sub>]." *Id.*

## 5. Benefit-disentitlement challenges

Several Samsung petitions presented challenges grounded on Acorn's Grupp '483 Patent as anticipatory prior art based on various arguments that certain claims were not entitled to the earliest filing date to which they claimed benefit under 35 U.S.C. § 120. The relevant one of those arguments in these appeals was that claims reciting "a metal oxide" as the separation layer in a two-layer interface – and their dependent claims – lacked written-description support for the entire genus of all metal oxides. That argument was set forth identically on pages 18-21 of the IPR2020-01206 petition (Appx00582-00585) and 18-22 of the IPR2020-01207 petition (Appx08090-08094). *See also* Appx03162-03164,

Appx03199-03204 (Dr. Schubert saying same); Appx11442-11444, Appx11478-11484 (same).

Specifically, the petitions stated, “The only possible example of a *metal oxide* interface layer described in any earlier parent application is a TiO<sub>2</sub> spacer layer,” Appx00582 (emphasis added); Appx08091 (same). The petitions continued, “[T]he relevant question is whether the earlier parent application[] ... provides written description of *the entire genus of metal oxide interface layers.*” Appx00583 (emphasis added); Appx08092 (same). The petitions concluded that the relevant “disclosures, whether taken alone or together, do not reflect the full variation *across the genus of metal oxide interface layers.*” *Id.* (emphasis added); *see also* Appx00584-00585 (“[L]one example of TiO<sub>2</sub> as a spacer layer cannot support claims to a *generic ‘interface layer comprising a metal oxide.*” (emphasis added)); Appx08093 (same).

The petitions never argued that “an oxide of titanium,” a phrase appearing in the Oxide-of-Titanium Claims as well as *unchallenged* independent claims 17 and 23 of the ’395 Patent, lacked written-description support. Instead, the petitions’ only mention of “oxide of titanium” was either mapping that limitation

to TiO<sub>2</sub> disclosed in Grupp '483 as part of its anticipation analysis, *see* Appx00602, Appx00605, Appx00608, Appx00616, Appx08112, or mentioning it as part of the Examiner's reasons for allowance in the prosecution history of the '395 Patent, Appx08084, Appx08118. There was no discussion in the petitions of the scope of the subgenus "oxide of titanium" and no assessment of whether TiO<sub>2</sub> was sufficient to support that subgenus.

Nor did the petitions propose any claim constructions for any language relating to the "oxide of titanium" limitation in those claims, as required by 37 C.F.R. § 42.104(b)(3). There was no analysis in the petition of how the Oxide-of-Titanium Claims should be interpreted relative to their base claims. *See* Appx00577-00579; Appx08086-08087 (construing only "specific contact resistivity ...").

## 6. POSITA definition

All petitions identically defined a POSITA as having either a Ph.D., Master's, or Bachelor's degree and either 2, 4, or 6-8, respectively, "years of practical experience with semiconductor research and design." *See, e.g.,* Appx00576-00577; Appx03192-03193; Appx08085-08086; Appx11472-11473;

Appx16361-16362; Appx19139-19140; Appx23283; Appx26883-26884. Dr. Goodnick<sup>3</sup> expressed concern that this definition was overly broad, saying, “[S]emiconductor research and design is a vast field, and a POSITA as defined by Samsung and Dr. Schubert, having practical experience with semiconductor research and design in general, would not necessarily be familiar with interfacial layers for metal-semiconductor junctions, the focus of the Acorn patents.” Appx21984. Dr. Kuhn agreed. *See* Appx07534 (“I share that concern.”). Samsung did not attempt to rebut those criticisms of its POSITA definition.

#### **D. Institution of IPR Trials**

The Board instituted trials in seven of the ten petitions, including all petitions that raised benefit-disentitlement arguments. The Board instituted two trials against the '691 Patent and two trials against the '395 Patent. Notably, all (non-)institution decisions that addressed Goodnick-Taubenblatt § 103 challenges (with or without other references) found those challenges not reasonably likely to prevail due to inadequate motivation to combine Goodnick and Taubenblatt.

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<sup>3</sup> Dr. Stephen Goodnick, lead author of the “Goodnick” paper, testified on behalf of Acorn, in addition to Dr. Kuhn.

The IPR2020-01279 institution decision explained the inadequacy of the proffered motivation, noting Dr. Schubert's reliance on many other references:

Although Dr. Schubert's testimony and his citation of various references disclose an interface layer can reduce resistivity, it is not clear that the subject matter cited by Dr. Schubert supports his assertion that a [POSITA] would have substituted Taubenblatt's titanium for Goodnick's aluminum.

Appx16641; *see also* Appx23551 (similar). The Board specifically acknowledged Samsung's reliance on Kim for "the use of titanium," Appx16640-16641; *see generally* Appx16637-16642, but explained that Kim taught away from pure titanium:

Kim discloses the use of an alloy of tungsten and titanium, and specifically identifies disadvantages to the use of aluminum and titanium alone .... Dr. Schubert's assertions that a [POSITA] would replace Goodnick's aluminum with Taubenblatt's titanium is inconsistent with Kim's disclosures concerning the use of a tungsten-titanium alloy consisting mostly of tungsten by weight.

Appx16642.

Moreover, in IPR2020-01264, the Board denied institution because the Board found that Kim does not teach forming a *layer* of TiO<sub>2</sub> to reduce resistance, as Samsung contended as shown



in the diagram on the right:

*Petitioner's Representation of Layers  
Allegedly Formed by Kim's Process*

However, even if [Kim] is sufficient to show that a reaction [generating TiO<sub>2</sub>] does occur, we find that Petitioner has not shown that the result would be an interface *layer* of [TiO<sub>2</sub>] as shown above. [Kim] simply says “to form silicon and [TiO<sub>2</sub>], a semiconductor, thereby reducing the interface resistance,” with nothing to indicate that formation takes place as a *layer*. We note that Petitioner characterizes the tungsten layer as a conductor, not part of an interface layer.

Petitioner's expert quotes the passage [Kim 4:63-5:1 (Appx03386-03387)] and then simply concludes that “after titanium reacts with the [SiO<sub>2</sub>], an interface layer that includes [TiO<sub>2</sub>] is disposed between [the conductive members and the semiconductors],” but offers no further explanation or evidence of why that would be the case. There is simply not enough evidence here for us to conclude that Kim discloses a layer of TiO<sub>2</sub> as shown in Petitioner's illustrations.

*Samsung Elecs. Co. v. Acorn Semi, LLC*, IPR2020-01264, Paper 20 at 18-19 (PTAB Jan. 13, 2021) (emphases in original). Samsung did not seek rehearing of that decision.

The seven trials were conducted on a common schedule, all depositions were consolidated, and there was one consolidated oral argument. *See, e.g.*, Appx00867-00868; Appx08362-08363; Appx16681-16682; Appx23600-23601; Appx03728-03733; Appx07645-07649; Appx07894; Appx01081-01083; Appx01234-01236. Acorn made the same arguments against the priority-disentitlement challenges in every applicable case and the same arguments against all obviousness challenges based on at least Goodnick and Taubenblatt in every applicable case. For the issues on appeal, there were no case-to-case variations in the parties' arguments or evidence presented below across the various cases (except that the applicable "Tungsten Claims" appear only in the '395 Patent).

## E. IPR Trials Regarding Goodnick-Taubenblatt Challenges

### 1. Acorn's responses

During the trials, Acorn responded to the Goodnick-Taubenblatt challenges by pointing out (1) titanium's resistivity is 16 times higher than aluminum's and (2) Kim's teaching against using titanium as a contact metal for silicon. *See* Appx16715-16725; Appx23634-23644. Those arguments were supported by testimony from Dr. Kuhn. In particular, regarding (1), she testified that for a realistic contact metal geometry, an aluminum contact would have a resistance of 12.5  $\Omega$ , whereas a titanium contact would have a resistance of 201.6  $\Omega$ . Appx07564-07565. Regarding (2), she explained the importance of thermal expansion:

A contact is essentially a tall thin vertical metal wire landing on silicon and surrounded by several different materials (oxide, nitride, silicon, and the like). In this geometry, expansion of the contact during fabrication will cause the contact and the surrounding material to expand. If the contact expands to a greater extent than the surrounding material, that can cause physical stress (and potential damage) to the surrounding material, much like freezing water expanding more than the pipe containing it until the pipe breaks. This is another reason why titanium would

be a poor choice for a metal plug because titanium is well known to have a coefficient of thermal expansion significantly greater than that of typical semiconductors (e.g., 3X that of silicon) ...

[I]n my experience, I have never encountered anyone making a contact of titanium. ... [T]here has been considerable research trying to find a more conductive conductor that would work acceptably well in place of tungsten. Titanium is certainly not a candidate for such a substitute.

Appx07566.

Acorn also presented objective indicia of nonobviousness, including commercial success, time lag, long-felt need, unexpected results, praise, and Samsung's behavior. *See* Appx16737-16758, Appx23656-23677.

Regarding commercial success, Acorn noted that the infringement verdict in the related litigation would prove that Samsung had practiced the claimed invention. Appx16747-16748; Appx23666-23667. That indeed happened. *See* Appx07889. Samsung stipulated that the accused products had been commercially successful, *see* Appx23054-23056, and Acorn pointed out the magnitude of that success for the accused products, including a 14% share of the nearly \$20 billion annual smartphone processor market, Appx16748, Appx23667;

Appx19941-19942; Appx23057-23060; Appx23066-23069; Appx23071-23073.

Acorn also explained the nexus to the claimed invention in that reduced MS junction resistance translated into smaller, faster, less-power-consuming transistors, resulting in smartphones being more powerful, running faster, and having longer battery life – features that consumers valued. Appx16749-16754; Appx23668-23673.

Regarding time lag, Acorn noted the 20 years between the publications of Goodnick and Taubenblatt, on one hand, and Acorn's invention, on the other hand, and pointed out that for two decades no one was able to make the allegedly obvious combination of Goodnick and Taubenblatt to reap the alleged benefits of doing so. *See* Appx16738; Appx23657.

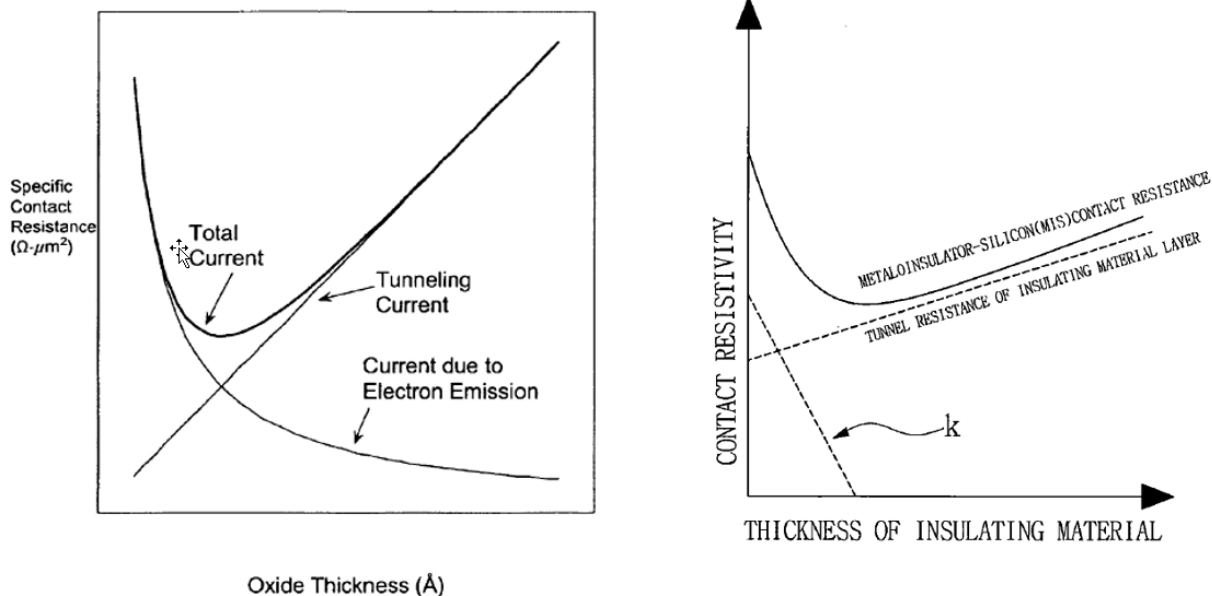
Regarding unexpected results and praise, Acorn presented copious evidence lauding the invention, for example, as a counterintuitive breakthrough. *See* Appx16739-16744; Appx23658-23663; Appx03385 1:12-18; Appx22760; Appx22780; Appx07525-07526; Appx22585-22589; Appx22594-22595; Appx22609-22611; Appx22074-22077; Appx22936-22945; Appx22946-22965.

Regarding long-felt need, Acorn explained that the semiconductor industry had

foreseen MS junction resistance as a limiting factor unless new solutions were found. *See* Appx16738-16739; Appx23657-23658.

Finally, Acorn noted that Samsung’s own actions objectively showed the invention to be patentable and valuable. For example, Samsung published a pre-paper abstract citing Acorn’s work but the subsequent full paper, which praised the invention, oddly no longer cited the inventors’ papers or otherwise attributed the invention to Acorn. Appx16754-16756; Appx23673-23675; Appx22060-22068. Also, Samsung sought patents for the same invention much later. *See* Appx22794-22892. In one case, Samsung filed its own patent application in 2015 with a graph (right) similar to Figure 8 of the Acorn patents (left):

FIG. 3B

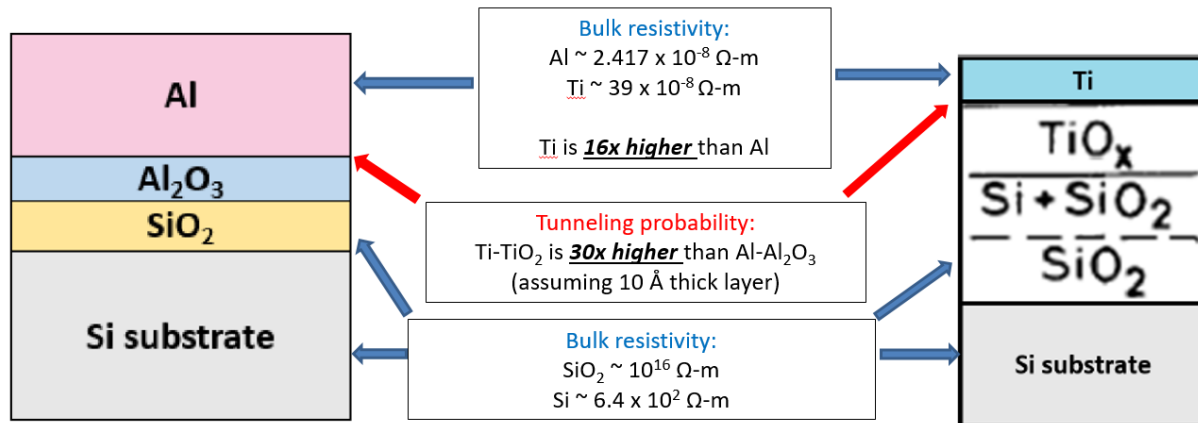


Appx00246; Appx07848; Appx16756-16757; Appx23675-23676. In another application, Samsung prosecuted to allowance but then mysteriously abandoned a claim highly similar to Acorn's claims. Appx16757-16758; Appx23676-23677; Appx22620-22623.

## 2. Samsung's replies

In its replies, Samsung conceded that titanium has significantly higher resistance than aluminum but presented several new arguments why the Goodnick-Taubenblatt structure would have less overall resistance than the Goodnick structure. Appx16830-16832; Appx23750-23752. Those new arguments included (1) claiming the resistance of the metal is negligible and asserting that the resistance of the semiconductor dominates ("10 billion times" more), Appx16828, Appx23748, (2) alleging that the tunnelling probability through the Ti-TiO<sub>x</sub> interface is 30 times higher than through the Al-Al<sub>2</sub>O<sub>3</sub> interface, Appx16829-16830, Appx23749-23750; and (3) introducing additional current mechanisms that would carry more current through the Ti-TiO<sub>x</sub> interface than through the Al-Al<sub>2</sub>O<sub>3</sub> interface, *id.*

Samsung’s new arguments were allegedly supported by a second set of declarations from Dr. Schubert, who relied on five new documents. *See* Appx21086-21093. Dr. Schubert presented the following side-by-side diagrams to support its comparison:



Appx21087; Appx16830; Appx23750.

Samsung also addressed Kim’s teaching-away, arguing that (1) “substituting titanium for aluminum would have improved the thermal coefficient match with silicon”; (2) alleging a contradiction to Dr. Kuhn’s statement that she had “never encountered anyone making a contact of titanium”; and (3) arguing that Kim’s teaching-away is limited to direct contact between silicon and titanium, whereas the proposed structure has intervening layers. Appx16833-16834; Appx23753-23754.

Samsung also disputed the objective indicia of nonobviousness *except* commercial success, which Samsung did not address. Appx16842-16853; Appx23763-23774.

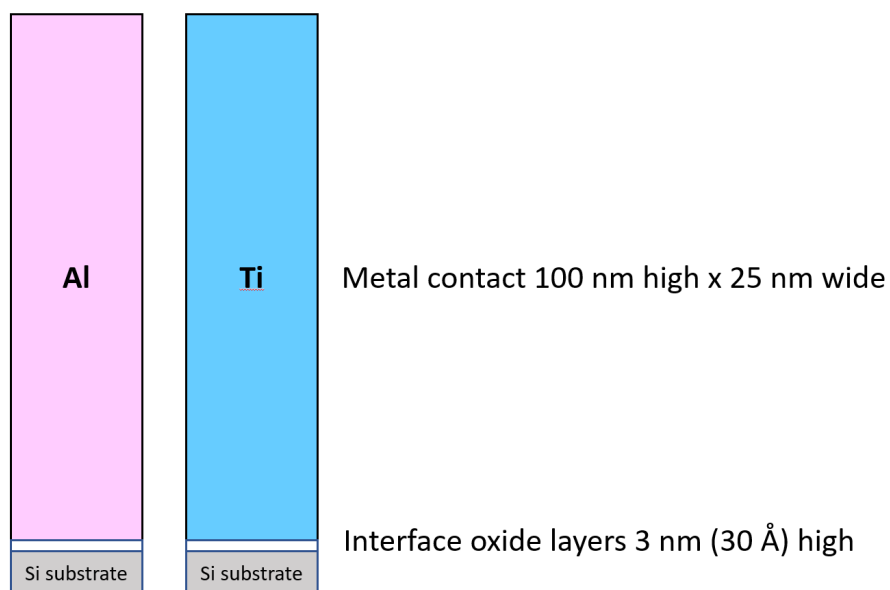
### 3. Acorn's surreplies

Acorn responded that the replies' new resistance-reduction theories should not be considered. Appx16911-16912; Appx23820-23821. Acorn also pointed out flaws in those theories and that Samsung still had not proven that resistance would decrease sufficiently to overcome titanium's 16X increase in resistance. Appx16905-16911; Appx23813-23820. Acorn, however, was unable to submit any rebuttal evidence under the Board's rules. *See* 37 C.F.R. § 42.23(b) ("A sur-reply ... may not be accompanied by new evidence other than deposition transcripts of the cross-examination of any reply witness.").

First, Acorn pointed out that Dr. Schubert's claim that silicon is "10 billion times" more resistive than metal assumed that the silicon was undoped (in fact, extremely pure) but that doping in the context of the invention reduced that number to just 100. Appx16905-16907; Appx23813-23815.

Second, Acorn disputed Dr. Schubert’s claim that the tunnelling probability at the Ti-TiO<sub>x</sub> interface is 30X more than at the Al-Al<sub>2</sub>O<sub>3</sub> interface, noting that Dr. Schubert’s calculations assumed a calculated electron affinity for Al<sub>2</sub>O<sub>3</sub>, rather than the measured value, which yielded only a 1.66X increase in tunneling probability. Appx16907-16908; Appx23815-23817. Acorn also noted that the Reply had failed to translate tunnelling probability into resistance or to quantify the alleged additional current mechanisms. Appx16908, Appx23816-23817.

Finally, Acorn noted that Dr. Schubert’s side-by-side diagrams distorted the length of the metal contact. Appx16909-16911; Appx23817-23819. Using Dr. Kuhn’s dimensions, Acorn produced the following alternative depiction:



Appx16910; Appx23818.

#### 4. FWDs

The Board issued two FWDs explaining that Samsung's motivation arguments were unconvincing, providing three reasons: (1) Samsung had failed to prove its resistance-reduction assertion; (2) Kim taught away from the proposed combination; and (3) Kim did not actually support Samsung's claim that resistance would decrease in the layered Goodnick-Taubenblatt arrangement Samsung proposed. The Board gave reasons (1) and (2) in the IPR2020-01282 FWD and reason (3) in the IPR2020-01279 FWD.

Regarding (1), the Board first noted, "Petitioner cites nothing from Goodnick that suggests using titanium and cites nothing from Taubenblatt 1982 that suggests substituting titanium for aluminum. Petitioner also cites nothing from either reference suggesting that Ti-TiO<sub>x</sub> would have produced a better [resistance] than Al-Al<sub>2</sub>O<sub>3</sub>." Appx00212 (citations omitted). Next, the Board considered whether the combination of (a) a 30X increase in tunnelling probability and (b) more thermionic-emission current would overcome titanium's 16X resistance disadvantage. *See* Appx00214-00217. The Board noted

(1) Dr. Schubert did not explain how those two effects translate to resistance or resistivity so as to “outweigh titanium’s increased resistivity” and (2) he made assertions (a) and (b) “without providing any evidence or calculations.” Appx00214.

The Board went on to discuss Dr. Kuhn’s example of a 12.5  $\Omega$  aluminum contact versus a 201.6  $\Omega$  titanium contact, noting specifically Samsung’s failure to address this example:

Dr. Schubert presents no calculations or estimates showing how in that example or in any other example the difference due to the change in tunnelling probability or lower barrier height at the interface would outweigh the difference in resistance in the contact metal. For instance, in Dr. Kuhn’s example, Dr. Schubert does not set forth how the difference in resistance due to the increase in tunnelling probability and the lowering of the barrier height with the Ti-TiO<sub>x</sub> interface would outweigh the 189.1  $\Omega$  (201.6  $\Omega$  – 12.5  $\Omega$ ) increase in resistance due to the metal in the contact.

Appx00215.

To drive the point home, the Board explained that even if the 30X increase in tunnelling probability were correct and even if that translated into a 30X decrease in resistance, and even if the lower barrier height caused another 10X

decrease in resistance, that would not be enough to outweigh the added metal resistance if the Al-Al<sub>2</sub>O<sub>3</sub> interface contributed only 30 Ω to the overall resistance. Appx00215-00216. That 30 Ω interface resistance would be reduced to 0.1 Ω, but that 29.9 Ω decrease would not offset the 189.1 Ω gain due to the change of metal. *Id.* Acknowledging that using a bigger number in place of 30 Ω could yield an overall decrease in resistance, the Board made the point that Samsung had failed to provide enough (indeed, any) evidence to show that its alleged resistance-reducing effects – even if true – would outweigh the higher resistance of the metal. Appx00216 n. 18.

The Board did not resolve the dispute about Al<sub>2</sub>O<sub>3</sub>'s electron affinity and thus whether the increased tunnelling probability would be 30X as Dr. Schubert alleged or just 1.66X as Acorn pointed out. Appx00216-00217 n. 19. As noted above, the Board gave Samsung the benefit of the doubt on this point.

Regarding (2), the Board explained that Kim teaches away from the use of pure titanium as the metal in a semiconductor junction – exactly what Samsung proposed with its Goodnick-Taubenblatt combination. Appx00212-00214.

First, the Board rejected Samsung's argument that titanium is a better thermal match than is aluminum, explaining that "[a POSITA] would recognize that Kim teaches that instead of pure titanium *or* aluminum, [a POSITA] should use an alloy of titanium and tungsten with a metal selected from the group of molybdenum and tungsten." Appx00213 (emphasis added).

Next, the Board explained that Kim's thermal-mismatch teachings are not limited to direct contacts: "We read Kim's teachings more broadly. ... Kim does not limit its teaching away from pure titanium to structures with direct contact and does not suggest that an intervening layer would make pure titanium suitable for contact." Appx00213-00214 (citations omitted). The Board also emphasized, "Petitioner cites no expert testimony to support its contention that Kim only teaches away from direct contact between titanium and silicon," and "Petitioner's contention that the intervening layer would make pure titanium suitable for contacts, based on Kim's teachings, rests solely on attorney argument, which is not persuasive." *Id.*

The Board separately explained that Kim did not actually support Samsung's claim that resistance would decrease in the layered Goodnick-

Taubenblatt arrangement that Samsung proposed. The Board noted Dr. Schubert's specific reliance on Kim for the assertion that titanium would result in lower resistance by generating TiO<sub>2</sub> but observed that Kim teaches reduced resistance using titanium-tungsten in *direct* contact with silicon, not in a *layered* arrangement like Goodnick's or Taubenblatt's. See Appx00144-000145. The Board noted that there are no teachings of a layer of TiO<sub>2</sub> in Kim and no evidence that a POSITA would apply Kim's speculations regarding the effect of TiO<sub>2</sub> on resistance to a *layered* arrangement. See Appx00145. Thus, the Board concluded that a POSITA would not have taken from Kim any suggestion to use titanium to reduce resistance in a layered arrangement: "Notwithstanding the bulk resistivity and tunnelling effect evidence discussed above, there is insufficient evidence to conclude that a [POSITA] would have combined the teachings of Goodnick and Taubenblatt as proposed by Petitioner." *Id.*

The Board considered the objective indicia only as to the claims found to be *prima facie* obvious (claim 4 of the '691 Patent and claims 4-5 of the '395 Patent). See Appx00150; Appx00192-00193. The Board found no nexus specifically for those claims. See Appx00152-00156; Appx00195-00201. The

Board failed altogether to consider time lag regarding the '691 Patent and dismissed it for the '395 Patent as not supported by long-felt need. Appx00196-00197. The Board also dismissed Samsung's behavior as not a recognized objective indicia. *See* Appx00156-00157; Appx00201-00202.<sup>4</sup>

#### F. IPR Trials Regarding the Benefit-Disentitlement Challenges

Regarding the Oxide-of-Titanium Claims, Acorn simply noted that the petitions had failed to specifically address their written-description support. *See* Appx00923-00927; Appx08417-08421. In its replies, Samsung presented new arguments and evidence, including extensive new testimony from Dr. Schubert, citing several new references. Appx00982-00987; Appx04192-04197; Appx08476-08481; Appx12455-12460. Samsung's new argument included a claim-construction argument that the Oxide-of-Titanium Claims could include other metal oxides as well as arguments about the scope of the "oxide of titanium"

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<sup>4</sup> If this case is remanded, the Board must reconsider the objective indicia, as the Board failed to take into account commercial success as to the infringed claims and their base claims, erred by requiring that time lag be tied to long-felt need (it may be tied to commercial success), and erred by dismissing Samsung's behavior as an unrecognized indicium. *See* 3 Moy's Walker on Patents § 9:55 (4th ed. Dec. 2020) (the possible secondary considerations is not "a closed list").

subgenus and whether  $\text{TiO}_2$  was sufficient to support that subgenus. *Id.* For example, Samsung identified seven different particular oxides of titanium and noted various different properties among three of them. Appx00983-00984; Appx08476-08478.

Acorn objected to Samsung's arguments regarding the Oxide-of-Titanium Claims as improper new arguments and, unable to submit any new rebuttal evidence, nonetheless pointed out flaws therein. Appx01054-01060; Appx08536-08542. For example, Acorn pointed out that the only possibly relevant oxides of titanium as the separation layer in the invention are dielectrics and that  $\text{TiO}_2$  is the only known dielectric among the oxides of titanium identified by Samsung. Appx01056-01058; Appx08538-08540. Acorn also disputed Samsung's claim-construction arguments first articulated in the replies. Appx01058-01060; Appx08540-08542.

The Board issued FWDs agreeing that Samsung's arguments regarding the Oxide-of-Titanium Claims were improper new reply arguments. Appx00024-00027; Appx00079-00081.

#### IV. SUMMARY OF ARGUMENTS

The Board found the Goodnick-Taubenblatt obviousness challenge was not adequately supported by a motivation. Substantial evidence supports that finding. Specifically, substantial evidence supports the Board's determinations that (a) Samsung failed to prove its proffered reduced-resistance motivation; (b) Kim, contrary to Samsung's assertions, does not support the purported reduction of resistance in the layered arrangement of materials according to the Goodnick-Taubenblatt combination; and (c) Kim teaches away from the proposed combination. Any one of these reasons alone is sufficient to affirm the Board's finding of inadequate motivation.

The Board did not abuse its discretion by not entertaining Samsung's new reply arguments regarding the Oxide-of-Titanium Claims. Samsung's new reply arguments included the same claim-construction argument that it now pursues on appeal. That claim-construction argument, like the evidence and arguments regarding the scope of the "oxide of titanium" subgenus and the specification's support for that subgenus, should have been in the petition but were not. Samsung's tardy arguments and evidence were well outside the Board's clear

guidelines for a proper reply. Entertaining Samsung’s late reply arguments would have either disrupted the tight trial schedule or violated Acorn’s due-process rights.

## V. ARGUMENTS

### A. Standards of Review

“The presence or absence of a motivation to combine references in an obviousness determination is a pure question of fact.” *In re Gartside*, 203 F.3d 1305, 1316 (Fed. Cir. 2000). Accordingly, the Board’s determinations whether a POSITA would have been adequately motivated to combine or modify the teachings of prior art are reviewed for substantial evidence. *Id.*

Substantial evidence is “such relevant evidence as a reasonable mind might accept as adequate to support a conclusion.” *Consol. Edison Co. v. Nat’l Labor Relations Bd.*, 305 U.S. 197, 229 (1938). “Under the substantial evidence standard of review, [this Court] must affirm a [Board] determination if it is reasonable and supported by the record as a whole, even if some evidence detracts from the [Board’s] conclusion.” *Hitachi Metals, Ltd. v. US*, 949 F.3d 710, 716 (Fed. Cir. 2020) (quotations omitted). “[T]he possibility of drawing two inconsistent

conclusions from the evidence does not prevent an administrative agency's finding from being supported by substantial evidence." *Consolo v. Fed. Maritime Comm'n*, 383 U.S. 607, 620 (1966). "This court does not reweigh evidence on appeal, but rather determines whether substantial evidence supports the Board's fact findings." *In re NTP, Inc.*, 654 F.3d 1279, 1292 (Fed. Cir. 2011). Thus, a party challenging determinations under the substantial-evidence standard "has chosen a course with a high barrier to reversal." *Mitsubishi Heavy Indus., Ltd. v. US*, 275 F.3d 1056, 1060 (Fed. Cir. 2001).

Whether the Board entertains new reply arguments not present in a petition is reviewed for abuse of discretion. *See Intelligent Bio-Sys., Inc. v. Illumina Cambridge Ltd.*, 821 F.3d 1359, 1367 (Fed. Cir. 2016). "Abuse of discretion is a highly deferential standard of appellate review." *Bayer CropSci. AG v. Dow AgroScis. LLC*, 851 F.3d 1302, 1306 (Fed. Cir. 2017). Giving deference to the judgment of the tribunal below is "the hallmark of abuse-of-discretion review." *Gen. Elec. Co. v. Joiner*, 522 U.S. 136, 143 (1997).

**B. The Board’s Finding of Inadequate Motivation to Combine Goodnick and Taubenblatt Should be Affirmed.**

**1. The Board’s finding of inadequate motivation was well explained and supported by substantial evidence.**

**a. Samsung’s failure to prove overall resistance would decrease.**

The Board thoroughly explained – and substantial evidence supports – its finding that Samsung failed to meet its burden to prove reduced overall resistance as a result of modifying Goodnick in light of Taubenblatt. *See* Appx00207-00217, particularly Appx00212-00217.

The Board first noted that neither Goodnick nor Taubenblatt “suggests substituting titanium for aluminum” and that “[n]either reference suggest[s] that Ti-TiO<sub>x</sub> would have produced a better [resistance] than Al-Al<sub>2</sub>O<sub>3</sub>.” Appx00212 (citations omitted). Even though Samsung’s reply resistance-reduction theories were new and dubious, the Board considered them. Specifically, the Board considered both (1) a 30X increase in tunnelling probability and (2) more thermionic-emission current but found no explanation how those two effects “would outweigh the increase[d] bulk resistivity of titanium.” Appx00215. The Board correctly noted that Dr. Schubert made assertions (1) and (2) “without

providing any evidence or calculations” and noted “[t]he absence of supporting calculations or other evidence.” Appx00214. The Board specifically discussed Dr. Kuhn’s example in which changing the contact metal from aluminum to titanium would increase resistance 189.1  $\Omega$ , noting Dr. Schubert’s failure to address that example, and even gave an illustration in which the interface layer would reduce resistance only 29.9  $\Omega$ : See Appx00215-00216. Accordingly, the Board adequately explained the deficiencies in Samsung’s reduced-resistance assertions.

That finding of deficient motivation is amply supported by substantial evidence, including: (1) the admitted fact that titanium’s resistivity is 16 times that of aluminum’s, Appx16830-16832, Appx23750-23752, Appx21086 (admission by Dr. Schubert); (2) undisputed evidence regarding the length of the metal in a realistic MS junction configuration of the type a POSITA would have had in mind when considering Samsung’s proposed substitution of titanium for aluminum, Appx07564-07565; (3) Dr. Kuhn’s testimony providing an example of metal resistance values based on realistic geometries for both titanium and aluminum metal contacts, *id.*; and (4) the complete absence of any evidence from

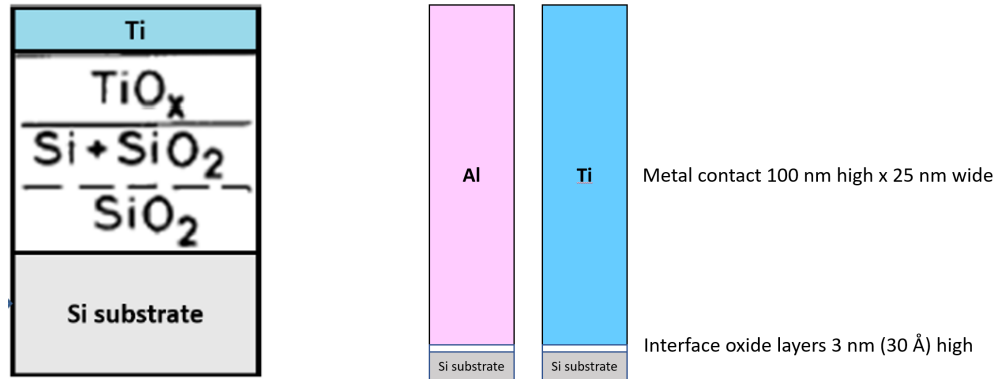
Samsung demonstrating that alleged higher tunnelling probability or other current mechanisms would have overcome the added resistance attributable to the titanium, Appx16827-16833, Appx23747-23753, Appx21082-21093.

The Board did not require mathematical precision from Samsung but was searching for some evidence that Samsung's alleged resistance-reducing effects would outweigh titanium's higher resistance. The Board found none. Faced with an admission regarding the magnitude of the resistance increased caused by titanium, on one hand, and no evidence that the alleged resistance-reducing effects in the interface would compensate or outweigh titanium's higher resistance, on the other hand, the Board correctly ruled in Acorn's favor. This Court should affirm that as a reasonable weighing of the evidence. *See NTP*, 654 F.3d at 1292.

Moreover, Dr. Schubert demonstrated in at least three ways that he lacked credibility, and the Board was free to take that into account. *See, e.g., Inwood Labs., Inc. v. Ives Labs., Inc.*, 456 U.S. 844, 856 (1982) ("Determining the weight and credibility of the evidence is the special province of the trier of fact.").

First, Dr. Schubert grossly overinflated the resistance of the semiconductor compared to the metal, claiming the difference was on the order of “10 billion.” Appx21086. That was off by a factor of 100,000,000. His false claim of “10 billion” was based on undoped (in fact, almost impossibly pure) silicon, but silicon is always doped in these devices, and he elsewhere testified that high doping was typical. Appx07924-07938; Appx07987; Appx16905-16906; Appx23813-23814. At his own admitted doping level, the difference in resistance is only on the order of 100. *Id.* While ultimately a red herring because the silicon is the same in both stacks of materials (Goodnick’s unaltered stack and the Goodnick-Taubenblatt stack), making no difference in an apples-to-apples comparison, his false “10 billion” claim demonstrates low credibility.

Second, Dr. Schubert failed to account for the metal length. Undisputed evidence showed that a typical metal contact was 100 nm long compared to an interface layer of about 3 nm. But Dr. Schubert’s diagram of the Goodnick-Taubenblatt combination failed to reflect that geometry accurately:



Appx16830; Appx23750; Appx16910; Appx23818 (Dr. Schubert’s depiction left; Dr. Kuhn’s right); *see also* Appx05712 (reference with scale similar to Dr. Kuhn’s); 2022-1499 Companion Case, Dkt. 13 at 5 (Fed. Cir. filed May 10, 2022) (Samsung’s depiction similar in scale to Dr. Kuhn’s). Of course, neither Goodnick nor Taubenblatt was attempting to build an electrical device, so a thin slice of metal on top may have been perfectly fine for their academic material-science research experiments. Dr. Schubert’s distortion of the dimensions of the metal contact was a second strike against his credibility.

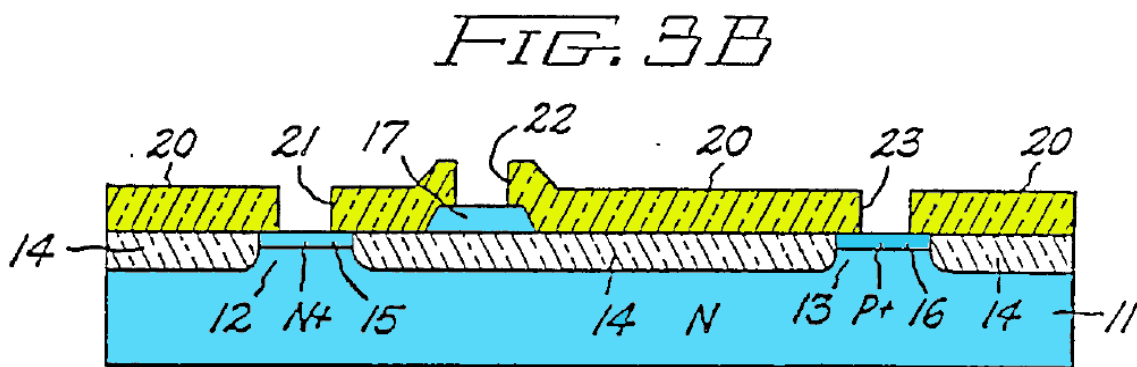
Third, Dr. Schubert’s assertion of a 30X increase in tunnelling probability was premised on a “calculated” electron affinity for Al<sub>2</sub>O<sub>3</sub>, rather than the actual “experimental” electron affinity. Appx16907-16908; Appx23815-23816; Appx19750. Conveniently, the calculated value worked in his favor. When the experimental value is used instead, the tunnelling probability is only 1.66X more.

Appx16907-16908; Appx23815-23816. Nor did he (1) establish what base to which the 30X (actually 1.66X) factor applies or (2) convert tunnelling probability into resistance so that an apples-to-apples comparison could be made. Appx16908; Appx23816-23817. Similarly problematic, that tunnelling probability was directed at just the metal-metal-oxide interface (*i.e.*, either Ti-TiO<sub>2</sub> or Al-Al<sub>2</sub>O<sub>3</sub>). But, what matters is the tunnelling through the entire interface from the metal to semiconductor, as illustrated in Figure 8 of the Acorn patents. This problem further highlights the flaws in Dr. Schubert's resistance-reduction assertions and his lack of credibility.

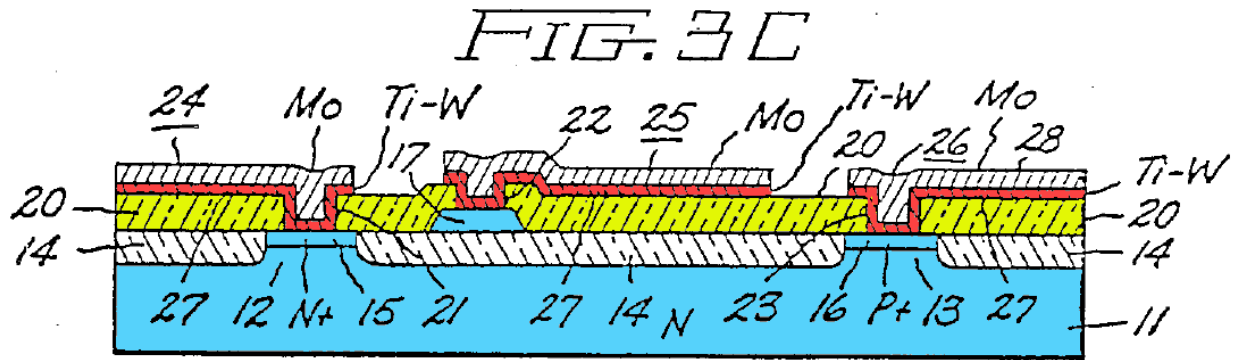
**b. Kim's failure to motivate a POSITA to use a layer of TiO<sub>2</sub> to reduce resistance.**

The Board also thoroughly explained – and substantial evidence supports – that Kim, the evidence Samsung primarily relied upon to support its reduced-resistance motivation, would not have suggested to a POSITA that TiO<sub>2</sub> can reduce resistance in a layered arrangement like Goodnick or the Goodnick-Taubenblatt combination. The Board explained this clearly on pages 32-35 (Appx00142-00145) of the IPR2020-01279 FWD.

Note that Kim's SiO<sub>2</sub> 20 is along the *sides* of the apertures (holes or wells) 21-23, as shown in Figures 3B-3C (Appx03384). Thus, there was no suggestion from this geometry that a horizontal layer of TiO<sub>2</sub> would form. And, to be sure, no such layer is illustrated in Figure 3C, which represents the final product. Nor does Figure 3B illustrate a layer of SiO<sub>2</sub> (yellow below) on the doped/conductive silicon members 15-17 (blue). In fact, Kim specifically teaches a cleaning and rinsing step "to remove native silicon oxide" on the doped/conductive silicon members 15-17 immediately before the tungsten-titanium alloy (red) is sputtered on.<sup>5</sup> See Appx03386 4:11-22. Finally, Kim merely hypothesizes that TiO<sub>2</sub> forms. See Appx03386-03387 4:65-5:4 ("It is believed ..."). Dr. Schubert presented no proof that such a reaction actually occurs.



<sup>5</sup> This is another way in which Kim teaches away. Kim eliminates SiO<sub>2</sub>, the passivating layer in the Acorn invention.



Regardless, even assuming that the reaction does occur to form  $\text{TiO}_2$ , the Board found “nothing to indicate that formation takes place *as a layer.*” Appx00145 (emphasis added). Thus, the Board “was not persuaded that Kim would have suggested to a [POSITA] replacing Goodnick’s aluminum with Taubenblatt’s titanium *in a layered structure.*” *Id.* (emphasis added). The Board therefore found Samsung’s resistance-reduction arguments – even if true (they are not) – inadequate in view of Kim, the linchpin the petition proffered to support its motivation. *Id.*

Kim itself is substantial evidence supporting the Board’s interpretation. As noted above, (1) Kim never mentions or illustrates an interfacial oxide layer between the metal and the semiconductor; (2) Kim, by its very terms, instead concerns contacts that are a titanium-tungsten alloy, not titanium; and (3) Kim expressly teaches the removal of native oxide on the silicon immediately before

addition of the titanium-tungsten alloy. *See* Appx03384 Figs. 3B-3C, Appx03386 4:11-25. Samsung now seems to agree with (3). *See* Samsung Br. at 60. Even if another interpretation of Kim were reasonably possible (it is not), these aspects of Kim would still constitute substantial evidence supporting the Board's interpretation, which this Court cannot supplant with its own judgment. *See, e.g., Akzo N.V. v. Int'l Trade Comm'n*, 808 F.2d 1471, 1487 (Fed. Cir. 1986) (appellate court may not "substitute [its] own judgment for that of the [Board]" under substantial-evidence standard).

**c. Kim's teaching-away.**

The Board also thoroughly explained – and substantial evidence supports – that Kim, in addition to not providing a motivation to reduce resistance in Goodnick's layered arrangement, taught away from the use of a pure titanium metal layer in a semiconductor junction – exactly what Samsung proposed with its Goodnick-Taubenblatt combination. That teaching-away was based on the thermal incompatibility of titanium and silicon.

Specifically, the Board addressed Samsung's argument that titanium is a better thermal match to silicon than is aluminum by explaining that Kim teaches

away from *both* pure titanium and aluminum and instead teaches that a tungsten-titanium alloy should be used. *See* Appx00213. This is consistent with the fact that neither Goodnick nor Taubenblatt was trying to build a working electronic device; they were just studying what happens when you put one material on another. *See* Appx20277 (lines 9-17), Appx20306 (lines 12-17), Appx20414 (lines 11-13), Appx20416 (lines 17-25).

The Board also explained that Kim's thermal-mismatch teachings are not limited to direct contacts. The Board observed, "Petitioner cites *no* expert testimony to support its contention that Kim only teaches away from direct contact between titanium and silicon." Appx00213 (emphasis added). The Board continued, "We read Kim's teachings more broadly. ... Kim does not limit its teaching away from pure titanium to structures with direct contact and does not suggest that an intervening layer would make pure titanium suitable for contact." Appx00213-00214 (citations omitted). The Board went on to note that Samsung's arguments on this point "rest[ed] solely on attorney argument, which is not persuasive." Appx00214.

Substantial evidence supports the Board’s findings that Kim taught away from using pure titanium. Samsung disputes this by contending that Kim’s teaching in this regard is limited to just the case of direct contact between titanium and silicon. *See* Samsung Br. at 58-61. Samsung even goes so far to emphasize that Kim teaches steps to “‘remove’ oxides from the surface, resulting in direct metal-to-semiconductor contact.” *Id.* at 60. As noted in § V-B-1-b *supra* at 49-50, however, that fact reinforces the Board’s finding that Kim would not have led a POSITA to apply Kim’s teachings to Goodnick’s *layered* arrangement.

Furthermore, a POSITA reading Kim with an “expansive and flexible” mindset, using “common knowledge and common sense” – as Samsung insists, *see id.* at 61-62 – would realize that Kim’s concerns about thermal mismatch are not limited to direct contact. Common sense dictates that an ultrathin interface layer – like the ones contemplated by Goodnick – would not ameliorate the thermal mismatch concerns at all. Perhaps an interface layer that is (1) sufficiently thick and (2) made of a material that is sufficiently deformable could ameliorate the thermal mismatch, but that is clearly not the case here. In the Companion Case, Samsung characterizes the thickness of this layer as “at atomic

dimensions a thousand times less than the thickness of a human hair.” 2022-1499 Dkt. 13 at 1. As an analogy, consider water pipes in which the interior has been lined with a thin coat of material as a liner to plug small leaks. Such pipes will still break if the water inside freezes notwithstanding that thin liner layer. *See* Appx17224-17225 75:20–76:7. Common sense dictates that the same would happen if there were an ultrathin 30 Å layer between silicon and titanium. Thus, substantial evidence supports the Board’s interpretation of Kim’s teaching-away as not limited to direct titanium-silicon contact. Other substantial evidence regarding Kim’s teaching-away includes the testimony of Dr. Kuhn. *See* § III-F-1 *supra* at 24-25.

Against that evidence, Samsung presented just attorney argument, as the Board noted. *See* Appx00213-00214. That is, Dr. Schubert did *not* testify regarding Kim’s teaching-away. But, “[a]ttorney argument is not evidence” and cannot rebut admitted evidence. *Icon Health & Fitness, Inc. v. Strava, Inc.*, 849 F.3d 1034, 1043 (Fed. Cir. 2017).

**2. Samsung's arguments fail.**

**a. The Board's reliance on Kim was proper.**

The Board properly looked to Kim when it found inadequate motivation. The Board did not *sua sponte* interject Kim into the motivation analysis. Samsung did. So did Acorn. And the Board gave Samsung loud and clear notice that Kim was relevant to the motivation issue in its decisions on institution.

The petitions cited Kim as the linchpin as to “why” a POSITA would allegedly have thought that the Goodnick-Taubenblatt combination would have less resistance than Goodnick alone. Neither Goodnick nor Taubenblatt is concerned with resistance or suggests the proposed combination with the other. The petitions therefore turned to Kim for the motivation, putting Kim directly at issue. The IPR2020-01279 petition, for example, cited Kim four times, *see* Appx16378-16381, and Dr. Schubert cited Kim six times to explain this “why” rationale. *See* Appx19168-19175. Samsung therefore cannot complain of an alleged error (citing Kim) that Samsung invited. *See Key Pharms. v. Hercon Labs. Corp.*, 161 F.3d 709, 715 (Fed. Cir. 1998).

The Board also explained Kim’s relevance in its decisions on institution. For example, the institution decision in IPR2020-01279 found that all Goodnick-Taubenblatt challenges were *not* reasonably likely to prevail because Kim undercut the petition’s motivation to combine. *See* Appx16637-16642; *accord* Appx23550-23552. Thus, the Board gave Samsung clear notice of the relevance (in fact, dispositive nature) of Kim to the motivation issue.

Additionally, Samsung was on notice that the Board had found Kim’s speculation that TiO<sub>2</sub> would reduce resistance inapplicable to a layered arrangement such as Goodnick or the proposed Goodnick-Taubenblatt combination. *See* § III-D *supra* at 22-23. Samsung ignored that finding at its own peril.

Even assuming *arguendo* that Acorn had never mentioned Kim, the Board would have been free to analyze Kim in its entirety to assess whether Samsung had met its burden to prove the Acorn patent claims unpatentable per 35 U.S.C. § 316(e). Once Kim was at issue, the Board was then free to “do[] its job, as adjudicator, of drawing its own inferences and conclusions.” *Rovalma, S.A. v. Bohler-Edelstahl GmbH*, 856 F.3d 1019, 1027 (Fed. Cir. 2017).

Moreover, Acorn cited Kim extensively in its responses, arguing that Kim defeated Samsung's proffered motivation. *See* Appx16721-16724; Appx23640-23643. The Board was therefore required to address Kim.

Samsung distorts what was a proper, reasonable, and evidentiarily well-supported use of Kim in the analysis of the motivation to combine. Samsung's position is essentially that it alleged the Goodnick-Taubenblatt combination would have less resistance than Goodnick alone, and that the Board erred by not crediting that fact by itself as sufficient motivation for a POSITA to have made the combination notwithstanding Kim. That is, Samsung would have the Board turn a blind eye to Kim, the very reference that Samsung itself put at issue. That thinking turns obviousness on its head. Obviousness requires that a POSITA – based on the prior art as a whole – would have recognized the purported motivation. *See Adapt Pharma Operations Ltd. v. Teva Pharms. USA, Inc.*, 25 F.4th 1354, 1372 (Fed. Cir. 2022) (“[F]act finder[,] was entitled to consider the teachings of the prior art as a whole.”). Kim is central to that question and (a) does not suggest that TiO<sub>2</sub> would reduce resistance in Goodnick-Taubenblatt's

layered structure and (b) teaches away from the combination even if the reduced-resistance motivation were true (it is not).

To the extent that Samsung complains that the IPR2020-01279 FWD relied on Kim differently from the IPR2020-01282 FWD, that complaint has no merit. The Board collectively gave three reasons why Samsung's motivation was deficient. All three reasons apply to all Goodnick-Taubenblatt challenges in either case. Samsung attempts to artificially isolate the IPR202-01279 case but it was one of a set of essentially consolidated cases below and the Goodnick-Taubenblatt issues, in particular, were the same in all cases. Here, two different Board judges on the panel wrote two opinions giving different and independent reasons why the Goodnick-Taubenblatt challenges failed, and both decisions reflect the judgment of the panel. Thus, even if the Board's use of Kim in the IPR2020-01279 IPR were improper (it is not), the Board's decision in IPR2020-01279 that the Goodnick-Taubenblatt challenges fail should be affirmed for all the reasons stated in the IPR2020-01282 FWD. *See Tesco Corp. v. Nat'l Oilwell Varco, L.P.*, 804 F.3d 1367, 1377 (Fed. Cir. 2015) (“[A]ppellate courts review judgments, not opinions.”).

**b. The Board did not employ an improper legal standard.**

Samsung argues that the Board employed an incorrect legal standard by allegedly comparing the Goodnick-Taubenblatt combination with Kim rather than with Goodnick alone. *See* Samsung Br. at 55-58. According to Samsung, the Board should not have considered Kim because the Goodnick-Taubenblatt combination has better thermal properties than Goodnick alone, and that was sufficient to show obviousness of the combination. *See id.* at 55-57.

There was nothing wrong with – and certainly no improper legal standard involved in – the Board’s analysis. Even if titanium is a better thermal match to silicon than is aluminum, the Board found that Kim teaches away from using *both* pure titanium and pure aluminum. *See* Appx00213 (“[A POSITA] would recognize that Kim teaches that, instead of pure titanium or aluminum, [a POSITA] should use an alloy of titanium and tungsten ...”). Substantial evidence supports that finding. Kim states that aluminum penetrates into silicon and “has a tendency to migrate” while pure titanium “is not suitable” due to thermal mismatch with silicon. Appx03385 1:12-30. Kim certainly does not teach, as Samsung seems to assume, that pure titanium is good enough because it is better

than aluminum. Kim instead teaches that neither titanium nor aluminum should be used as a contact metal for silicon. Samsung's alternative reading of Kim, even if reasonable (it is not), does not compel reversal. *See In re Bayer Aktiengesellschaft*, 488 F.3d 960, 970 (Fed. Cir. 2007) ("Where two different conclusions may be warranted based on the evidence of record, the Board's decision to favor one conclusion over the other is the type of decision that must be sustained by this court as supported by substantial evidence."); *Consolo*, 383 U.S. at 620 (same). The Board reasonably relied on and interpreted Kim as teaching away from using pure titanium as Samsung proposed.

**c. Samsung's attacks on Kim's teaching-away are meritless.**

Samsung makes various arguments that the Board erred in finding that Kim teaches away from its Goodnick-Taubenblatt combination. Those arguments lack merit. Kim certainly does criticize, discredit, and discourage the use of pure titanium in contacts.

First, Samsung attempts to characterize Kim's teaching-away as merely a teaching of an undesirable but nonetheless obvious combination. *See Samsung Br.* at 57-58. But Kim does not merely teach that pure titanium is less desirable

than a tungsten-titanium alloy. Kim plainly says “[p]ure titanium ... is *not suitable* for contacts ... .” (emphasis added). “[A] reasonable mind might accept [that plain statement] as adequate to support a conclusion” that Kim teaches away. *Consol. Edison*, 305 U.S. at 229. Substantial evidence therefore supports the Board’s finding that Kim teaches away from Samsung’s proposed combination. *See id.*

Second, Samsung argues that Kim’s teaching-away from pure titanium is limited to direct contact with silicon. *See Samsung Br.* at 58-60. However, as explained above, the Board reasonably found that Kim’s concerns about the titanium-silicon thermal mismatch are not limited to direct contact, and substantial evidence supports that finding. *See § V-B-1-c supra* at 50-53.

Third, Samsung cites one statement from Dr. Kuhn’s deposition (“Titanium has commonly been used as the metal ... in the metal-insulator-semiconductor junction.”) as support for its position. *See Samsung Br.* at 60. That statement, however, does not undercut Kim’s teaching-away from the use of pure titanium. Even taking that one statement in the light most favorable to Samsung, it is, at most, just one piece of evidence compared to a mountain of evidence supporting

Kim's teaching-away. In these circumstances, that single statement does not detract from the substantiality of the other evidence (like Kim itself) supporting the Board's finding. *See Hitachi Metals*, 949 F.3d at 716. The Court cannot overturn the Board's factual finding just because Samsung cites one item of contrary evidence. Nor can the Court reweigh the evidence. *See NTP*, 654 F.3d at 1292.

To be clear, that one deposition statement does not reflect the entirety of Dr. Kuhn's testimony on this topic. In other testimony, she clearly stated that titanium was "never" used in the context of the invention. Appx07566. Thus, her overall testimony is not as Samsung portrays, and Samsung did not explore this topic further in her deposition to try to reach a definitive resolution. Notably, she was not asked about and did not answer regarding titanium and *silicon*, the particular semiconductor in the proposed combination and the particular semiconductor Kim teaches not to use with titanium. Appx20276 (lines 16-24). Instead, she responded to a question about a generic *semiconductor*. *Id.* Perhaps she had in mind some semiconductor other than silicon. No follow-up questions were asked to explore that. Nor did she say when

or under what circumstances titanium was “commonly” used in an MIS junction. *Id.* She, no doubt, had in mind some applications far afield from this invention (because the question was not appropriately focused). In fact, there may be other MIS structures in completely different contexts in which resistance and thermal characteristics are less important. Again, no follow-up ruled out such possibilities. She certainly did not say using pure titanium was a good idea.

Finally, she said that “people were aware you *could* use titanium as the metal in the metal-insulator-semiconductor junction.” *Id.* (emphasis added). Indeed, the question posed to her was also framed in terms of “could.” *Id.* But the test for obviousness is what a POSITA “would have” known and found obvious, not what a POSITA “could have” done. *See Belden Inc. v. Berk-Tek LLC*, 805 F.3d 1064, 1073 (Fed. Cir. 2015).

**d. Samsung’s attacks on the Board’s analysis of the reduced-resistance motivation are meritless.**

Samsung attempts to fault the Board for allegedly requiring that Samsung prove its resistance-reduction assertion with “mathematical precision” or “mathematical certainty.” *See* Samsung Br. at 33, 54. However, Samsung framed the resistance comparison numerically, making outlandish claims about the

insignificance of the metal's resistance and an alleged increase in tunneling probability. Yet, Samsung did not finish the job, as the Board recognized. *See* Appx00214-00217. Samsung did not compare the overall resistance of the Goodnick-Taubenblatt stack to the Goodnick stack. In fact, Samsung did not enable a meaningful apples-to-apples comparison of the two stacks. That was not just a failure to quantify; it was a failure to put in proof of any form to enable a comparison. Instead, Dr. Schubert just made "conclusory" assertions that various resistance phenomena in the interface would outweigh the admitted increase in resistance of titanium. Appx00216. Samsung is now understandably disappointed that the Board did not use unspecified background knowledge and common sense of a POSITA to fill the holes in Samsung's case, but that is not error. It is, instead, the Board's spotting Samsung's handwaving and not being fooled by it.

Samsung also faults the Board for not weighing the resistance advantages and disadvantages of the Goodnick-Taubenblatt combination compared to Goodnick alone and not fully crediting a POSITA's background knowledge and common sense, both of which, according to Samsung, support finding a lower

resistance in the Goodnick-Taubenblatt interface than in the Goodnick interface. *See* Samsung Br. at 29, 61-63. However, the Board certainly did try to weigh the resistance advantages and disadvantages of the Goodnick-Taubenblatt combination compared to Goodnick alone. *See* Appx00214-00217. In particular, the Board noted the undisputed 16X resistivity disadvantage of titanium, credited Dr. Kuhn's example of metal resistances for a typical geometry, and searched in vain for a resistance advantage at the interface to make a meaningful comparison. *Id.* Along the way, the Board gave Samsung the benefit of every doubt, even ones that are highly suspect and procedurally questionable. *Id.*; *see* §§ III-F-2 – III-F-3 *supra* at 28-32.

**e. Samsung overinflates POSITA's knowledge.**

Samsung's appeal to a POSITA's background knowledge and common sense is especially flawed. Samsung ignores the fact that a POSITA's knowledge here was quite limited regarding the specialty of MIS interfaces. *See* § III-C-6 *supra* at 19-20.

Samsung's POSITA definition was not a careless choice. Giving a POSITA too much specialized MIS expertise would risk weakening Samsung's § 112

challenges. Samsung chose a definition favoring its § 112 challenges, but that choice worked against its § 103 challenges. Specifically, the motivational reasoning outlined in the petitions was a tortuous path relying on alleged insights from many other references unnamed in the challenge grounds in the highly specialized subfield of MIS junctions – a lot to ask of a generalist semiconductor POSITA as defined by Samsung. *See, e.g.*, Appx23306-23309. Unsurprisingly, the Board found that the reduced-resistance rationale was too complicated to motivate a Samsung-defined POSITA unguided by hindsight. *See, e.g.*, Appx23551; Appx00216-00217.

Moreover, the law does not permit the reliance on common sense and common knowledge that Samsung pushes. *See Arendi S.A.R.L. v. Apple Inc.*, 832 F.3d 1355, 1362 (Fed. Cir. 2016) (“‘[C]ommon sense’—whether to supply a motivation to combine or a missing limitation—cannot be used as a wholesale substitute for reasoned analysis and evidentiary support.”).

Overall, Samsung left too big a hole to fill with common sense and background knowledge.

f. **The Board's not finding the "Tungsten Claims" obvious should also be affirmed.**

Samsung argues that the Board erred regarding the Tungsten Claims ('395 Patent claims 20, 21, 26, and 27) because Samsung's proposed combination against those claims included Kim and therefore proposed a tungsten-titanium alloy as the contact metal. *See* Samsung Br. at 67-69. There are at least two flaws in that argument.

First, the petition specifically proposed a step-wise obviousness case. Step one was combining Goodnick and Taubenblatt. Step two was modifying *that combination* to use Kim's tungsten-titanium alloy in place of Taubenblatt's titanium. *See* Appx23331 ("[A POSITA] would have found it obvious to substitute Kim's titanium-tungsten alloy for Taubenblatt 1982's titanium *in the combination of Goodnick and Taubenblatt 1982 discussed above ...*" (emphasis added)); *see also* Appx26983 (Dr. Schubert saying same). As explained above, the Board reasonably found that step one would not have been obvious to a POSITA. *See* Appx00220-00221. Perforce, the Board never reached step two.

Second, even if the petition could be read as not building a step-wise obviousness case (*i.e.*, if the petition actually proposed that a POSITA jointly look

at the three references and in one fell swoop combine all three), that would only eliminate the concern about thermal mismatch. Samsung still failed to prove a reduction in resistance. Even in a three-way-combination-all-at-once, the proffered motivation for making that combination would be reduced resistance, and that motivation would still be inadequate. While Samsung now criticizes Acorn for not submitting evidence that a Goodnick-Taubenblatt-Kim combination having a tungsten-titanium alloy as the metal would not have lower overall resistance, *see* Samsung Br. at 69, Acorn was under no obligation to disprove a proposition for which Samsung bore the burden of proof. Samsung bore the burden to show that a POSITA would have been motivated by a reduction in resistance to make the Goodnick-Taubenblatt-Kim combination with a tungsten-titanium alloy as the metal, but Samsung failed to do so. Instead, Samsung's only resistance-reduction arguments were directed at the base Goodnick-Taubenblatt combination, but, as explained above, that showing was deficient.

Besides, Samsung never argued below that Acorn's resistance-reduction arguments were inapplicable to the Tungsten Claims. *See* Appx23762-23763.

Samsung has therefore forfeited that argument. *See In re DBC*, 545 F.3d 1373, 1378 (Fed. Cir. 2008).

**C. The Board’s Decision on the Benefit-Disentitlement Challenges Should Not be Disturbed But For Correcting a Clerical Error.**

- 1. The Board did not abuse its discretion by refusing to entertain Samsung’s improper reply arguments directed at the Oxide-of-Titanium Claims.**
  - a. The petitions were incomplete regarding the Oxide-of-Titanium Claims.**

The Board’s refusal to hear Samsung’s reply arguments is Samsung’s own fault, due to its failure to address the narrower Oxide-of-Titanium Claims in the petitions or to advance a claim construction that would obviate addressing those claims separately. Samsung has since tried to backfill its deficient petitions. That is exactly what Federal Circuit and Board authority prohibits.

Samsung tries to justify its new reply arguments as “responsive to” Acorn’s arguments. *See Samsung Br.* at 44. However, mere responsiveness is not the test for proper reply arguments. Every conceivable reply argument is “responsive” in a broad sense. But, a proper reply argument cannot go in a new direction, espouse a new theory, or present arguments that could have been included in the petition:

“Respond,” in the context of 37 C.F.R. § 42.23(b), does not mean proceed in a new direction with a new approach as compared to the positions taken in a prior filing. ... [A] reply or sur-reply that raises a new issue or belatedly presents evidence may not be considered. ... Examples of indications that a new issue has been raised in a reply include new evidence necessary to make out a prima facie case for ... unpatentability ... It is also improper for a reply to present new evidence (including new expert testimony) that could have been presented in a prior filing ... .

PTAB Consol. Trial Practice Guide (“TPG”) at 73-75 (Nov. 2019).<sup>6</sup>

Here, Samsung’s replies went in a new direction, espousing new theories that could have been but were not included in the petitions, *viz.*, how the Oxide-of-Titanium Claims should be interpreted, what is the scope of the “oxide of titanium” subgenus, and whether TiO<sub>2</sub> adequately supports that scope. None of those issues were in the petitions, which instead focused exclusively on the genus “metal oxide” in the independent claims and whether TiO<sub>2</sub> adequately supports that genus. *See* § III-C-5 *supra* at 17-19, § V-C-1-b *infra* at 71-72.

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<sup>6</sup> Available at <https://www.uspto.gov/sites/default/files/documents/tpgnov.pdf>.

Notably, the Board here was enforcing *its own* rule (37 C.F.R. § 42.23(b)) pursuant to *its own* guidance (TPG). This is a situation in which deference under the “highly deferential” abuse-of-discretion standard should be at its zenith. *Bayer CropSci.*, 851 F.3d at 1306; *see also Belden*, 805 F.3d at 1081 (recognizing Board’s “broad discretion to regulate the presentation of evidence” in reply).

Indeed, the Board’s decision whether to consider Samsung’s new reply arguments required a careful balancing of the fairness to the parties in the specific circumstances of these cases in their unique posture when this issue arose: Did Samsung have a chance to raise these arguments in the petitions? Would Acorn have had a fair chance to respond if these new reply arguments (and their supporting evidence) were considered? The Board reasonably answered those questions yes and no, respectively. That judgment deserves deference and should not be second-guessed under the abuse-of-discretion standard. *See Gen. Elec.*, 522 U.S. at 143; *see also Belden*, 805 F.3d at 1081-82 (explaining that Board’s scope-of-reply rules are “employed to provide the required procedural fairness through careful case-specific application.”); *Ariosa Diagnostics, Inc. v. Verinata Health, Inc.*, 805 F.3d 1359, 1368 (Fed. Circ. 2015) (“Board must make judgments

about whether a Petition identified the specific evidence relied on in a Reply and when a Reply contention crosses the line from the responsive to the new.”); *In re Lee*, 277 F.3d 1338, 1342 (Fed. Cir. 2002) (“[W]e must not ourselves make factual and discretionary determinations that are for the agency to make.”).

**b. Samsung’s replies did not advance the same theory as the petitions regarding the Oxide-of-Titanium Claims.**

Samsung argues that its replies advanced the same unpatentability theory as in the petition. *See* Samsung Br. at 47. But Samsung overbroadly states the petition’s theory, which is not fairly characterized as “TiO<sub>2</sub> ... is insufficient to ... support [all challenged] claims.” *Id.* Instead, the petitions actually said, “No parent application ... describes *a generic ‘metal oxide’ layer.*” Appx00582 (emphasis added); Appx08090 (same). The petition also said, “[T]he relevant question is whether the earlier patent applications[] ... provides written description of *the entire genus of metal oxide interface layers.*” Appx00583 (emphasis added); Appx08092 (same). The Board recognized this. For example, both FWDs note, “Petitioner asserts that *the* relevant question for this written description/priority issue is whether the pre-2011 priority applications’ [disclosure of] ‘e.g., TiO<sub>2</sub>’ ... provides a written description of *the entire genus of*

*metal oxide interface layers.*” Appx00067 (citing Appx08092, Appx00276 18:6-8) (emphases added); *see also* Appx00019 (same). Nothing in the petitions states or implies that another issue is whether TiO<sub>2</sub> provides written description for the subgenus of oxides of titanium.

**c. The Board did not abuse its discretion by declining to entertain Samsung’s new claim-construction argument.**

Samsung’s attempt to transform this simple discretionary procedural issue into a claim-construction issue fails. These appeals do not present a *de novo* question of whether the Board’s claim construction of the Oxide-of-Titanium Claims is correct, as Samsung asserts. *See* Samsung Br. at 35, 43. Rather, it is a question of whether Samsung raised this claim construction issue timely or tardily. The Board said it was tardy, and the question on appeal is whether the Board abused its discretion by answering in that way. As explained above, the Board acted well within its discretion.

To be clear, the Board did not commit a claim construction error. In fact, the Board did not construe the Oxide-of-Titanium Claims at all. Nor did Acorn advance a construction that the Board adopted *sub silentio*, as explained below. Rather, the Board refused to consider Samsung’s “comprises” claim-construction

because it was tardily raised in the replies, not the petitions. *See* Appx00025-00026 (citing 37 C.F.R. § 42.23(b) and TPG at 73); Appx00079-00080 (same). Indeed, the Board's denying the motion to exclude Dr. Kuhn's testimony regarding the scope of the Oxide-of-Titanium Claims as moot further shows that the Board simply refused to entertain Samsung's late claim-construction issue at all. Appx00046-00047; Appx00098. Had the Board actually adopted a construction, it surely would not have considered her testimony moot.

Acorn did not advance a construction, not even implicitly. Acorn just noted the legal principle that dependent claims are narrower than their base claims, *see* pre-AIA 35 U.S.C. § 112, ¶ 4, and the self-evident fact that "oxide of titanium" is narrower than "metal oxide." Appx00923-00927; Appx08417-08421.

Samsung cites *Ericsson, Inc. v. Intellectual Ventures I LLC*, 901 F.3d 1374, 1380 (Fed. Cir. 2018). *See* Samsung Br. at 44. *Ericsson* is distinguishable because Samsung could and should have raised this claim construction issue in its petitions, in which case the dispute could have been fairly and fully briefed. 37 C.F.R. § 42.104(b)(3) requires exactly that. Samsung was master of its petitions and chose to use its available words as it saw fit. Samsung – by neglect or choice

– omitted this issue from its petitions at its own peril. And the omission is consistent with the fact that Samsung did not challenge claims 17 and 23 of the '395 Patent, which recite the same limitations but in independent, rather than dependent, claims.

**d. Samsung's attempts to blame Acorn fail.**

Samsung frames the issue incorrectly when it asserts that Samsung could not have predicted Acorn's claim-construction position. *See* Samsung Br. at 45. If Samsung had instead put its new theory in its petitions – as 37 C.F.R. § 42.104(b)<sup>7</sup> required it to do – then Samsung would not have had to predict anything Acorn did. Again, Samsung's failure to timely frame this issue in the petitions was its own fault.

Samsung blames Acorn for not foreshadowing this issue in its preliminary responses. *See* Samsung Br. at 45. But Acorn was not required to take any claim-construction positions in its preliminary responses, or to file preliminary responses at all. And positions taken in a preliminary response must be repeated

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<sup>7</sup> 37 C.F.R. § 42.204(b), the analogous rule for post-grant review, is perhaps more apt for the benefit-disentitlement challenges in these IPRs.

in the response, else they are waived. *See In re Nuvasive, Inc.*, 842 F.3d 1376, 1381 (Fed. Cir. 2016). Thus, the absence of a claim construction for the Oxide-of-Titanium Claims in the preliminary responses means nothing. Concomitantly, Samsung's view that Acorn took a claim-construction position "for the first time" in its responses is misguided. *See* Samsung Br. at 45. In fact, Acorn was not required to take any claim-construction positions at all. The IPR rules are designed such that the petitioner is the only one required to state its claim constructions. *See* 37 C.F.R. § 42.104(b)(3); TPG at 44-45; *accord Intelligent Bio-Sys.*, 821 F.3d at 1369 (noting "obligation for petitioners to make their case in their petition").

Samsung also attacks Dr. Kuhn's testimony regarding the Oxide-of-Titanium Claims. *See* Samsung Br. at 45. Those attacks are misplaced. Specifically, Samsung thinks it is significant that she did not know how many oxides of titanium there are. *See id.* That is significant but not for the reasons Samsung asserts. She need not have been prepared to address that topic ***because that topic was not raised in the petitions.*** Accordingly, she did not testify about that topic in her declaration, and questions about that topic in her deposition

were outside the scope of her declaration. *See* Appx03841 (lines 10-12) (scope objection); *see also* 37 C.F.R. § 42.53(d)(5)(ii) (“[T]he scope of [cross-]examination is limited to the scope of the direct testimony.”). The same goes for the question about whether the claims would cover a newly discovered oxide of titanium. *See* Samsung Br. at 46. Plus, that was an objectionable question. *See* Appx03826 (lines 1-14).

**e. Remand to consider Samsung’s new reply arguments would be problematic.**

While remand is certainly not appropriate here (affirmance is), a remand would require that Acorn be given an opportunity to respond to Samsung’s new theory. As the record now stands, Samsung submitted an expert declaration, which cited numerous new documents, supporting its new theory. Acorn was unable to submit any evidence in response. *See* 37 C.F.R. § 42.23(b). A fair remand proceeding would need to allow Acorn a full and fair opportunity to respond. *See* 5 U.S.C. § 556(d). The need to craft a fair proceeding, by the way, was more than enough justification for the Board to exercise its discretion not to entertain Samsung’s new reply theory. The Board, knowing that Acorn had not had a fair chance to respond, would have had to bend its rules and probably its

trial schedule to restore fairness if it had entertained Samsung's new reply arguments.

**2. Samsung's new reply arguments lack merit.**

**a. Samsung's new claim-construction argument**

The Court need not and should not decide the claim construction issue Samsung poses. But, out of an abundance of caution, Acorn explains why Samsung's tardy construction is substantively flawed.

Claim 11 of the '395 Patent is representative of the Oxide-of-Titanium Claims. It depends from claim 1, which recites "an interface layer ... comprising *a* metal oxide and a semiconductor oxide," and claim 11 further recites "wherein *said* metal oxide comprises an oxide of titanium." '395 Patent at 18:50-51, 19:18-19 (emphases added). This plain language indicates there is one metal oxide in the independent claims, and the dependent claim specifies *that* singular metal oxide to be an oxide of titanium. *See Abtox, Inc. v. Exitron Corp.*, 131 F.3d 1009, 1024 (Fed. Cir. 1997) ("This term itself, 'said chamber,' reinforces the singular nature of the chamber.").

Significantly, in the district court Samsung did not advance the claim construction it now advocates. Rather, Samsung *agreed to* a different construction: “said interface layer comprising a metal oxide and a semiconductor oxide” as “said interface layer comprising *a* metal oxide and a distinct layer of *a* semiconductor oxide” Appx05559-05560; Appx05799-05800 (emphases added). The Board adopted the same construction. *See* Appx23532. Neither the Board nor the court construed this as Samsung now contends, *i.e.*, “said interface layer comprising [*one or more*] metal oxide[s] and a distinct layer of [*one or more*] semiconductor oxide[s].”

Samsung now argues that “a” means one or more. *See* Samsung Br. at 40-41. However, it is “not ... a hard and fast rule that ‘a’ always means one or more than one. Instead, we read the limitation in light of the claim and specification to discern its meaning. When the claim language and specification indicate that ‘a’ means one and only one, it is appropriate to construe it as such even in the context of an open-ended ‘comprising’ claim.” *Harari v. Lee*, 656 F.3d 1331, 1341 (Fed. Cir. 2011) (citations omitted); *accord Abtox*, 131 F.3d at 1024; *N. Am. Vaccine, Inc. v. Am. Cyanamid Co.*, 7 F.3d 1571, 1575-76 (Fed. Cir. 1993);

*Wonderland Nurserygoods Co. v. Baby Trend, Inc.*, 727 F. App'x 1017, 1018-19 (Fed. Cir. 2018) (nonprecedential).

Here, the specification never discloses what Samsung wants to stretch the claims to cover – a MIGS separation layer that comprises multiple metal oxides. Nor does the specification contemplate multiple MIGS separation layers. While the specification describes a multi-layer interface layer, such is always one passivating layer and one spacer/separation layer, in which case both layers perform a separation function. The specification never teaches a plurality of separation layers in addition to a passivation layer in the same interface. The passage at 9:63–10:11 of the '691 Patent (Appx00251) or 10:8-24 of the '395 Patent (Appx00272) is not to the contrary. In that passage, the use of plural “separation layers” refers to the numerous potential spacer layer materials, just as the plural “passivation layers” refers to the numerous potential passivation layer materials. It is a misreading of this passage to infer that multiple non-passivating spacer layers (or multiple passivation layers) should be used in any particular structure.

At bottom, the claims cannot be stretched broader than the written description. *Netword, LLC v. Centraal Corp.*, 242 F.3d 1347, 1352-53 (Fed. Cir. 2001); *Kinik Co. v. Int’l Trade Comm’n*, 362 F.3d 1359, 1364 (Fed. Cir. 2004); *accord Abtox*, 131 F.3d at 1027 (“[T]he claim language, as interpreted in light of the specification, limits the microwave devices to a single gas-confining chamber,”). Ironically, by trying to convert this written-description issue into a claim-construction issue, Samsung seeks to construe the claims beyond their written description so that it can say they lack written description. That is improper.

Finally, the fact that this claim-construction issue is not clearly in Samsung’s favor just reinforces that the Board did not abuse its discretion by choosing not to try to resolve this issue based on the one-sided record that it had before it at the time and did not want to bend its rules (and probably adjust its schedule) – both of which the Board is loath to do – to have a full and fair proceeding on this issue. In these circumstances, it was reasonable for the Board to enforce its rules against new reply arguments that could have been in the petition. There is no abuse of discretion in that.

**b. Samsung's other new reply arguments**

Samsung's other new arguments against the Oxide-of-Titanium Claims also fail. Those new arguments attempted to characterize the scope of "oxide of titanium" broadly and asserted that TiO<sub>2</sub> was not representative of that broad scope. *See* Appx00982-00987; Appx08476-08481. But, there are just a few suitable oxides of titanium, and Samsung's efforts to concoct unsuitable ones miss the point. Specifically, Samsung failed to identify any oxide of titanium other than TiO<sub>2</sub> as a solid dielectric at room and operating temperatures so as to function as a MIGS separation layer in the claimed configuration, as the Oxide-of-Titanium Claims require. *See* Appx01056-01057; Appx08538-08539; Appx07555-07558, Appx03815-03819; Appx04540; Appx07843-07885; Appx07556-07558. For example, it is preposterous to imagine that a superconducting oxide of titanium – or any conductor at all – could function as a MIGS separation layer. A superconductor, like any other conductor or metal, would induce gap states, perhaps to a "super" extent – not mitigate MIGS (*metal*-induced gap states). *See* Appx07558.

Moreover, Samsung admitted that TiO<sub>2</sub> is the dominant oxide of titanium in the context of the invention: “[TiO<sub>2</sub> is] the oxide of titanium most likely to form when titanium reacts with [SiO<sub>2</sub>].” Appx16381; Appx23308-23309. Dr. Schubert said the same thing: “[TiO<sub>2</sub>] is the most energetically favored (and therefore the most likely) oxide of titanium to form.” Appx19173; Appx26945 (same).

### **3. Claims 18 and 26-29 of the '691 Patent**

The Board misstated the disposition of these claims in the “CONCLUSION” and “ORDER” sections of the IPR2020-01206 FWD (Appx00049-00051), which should have listed those claims as unpatentable because the Board found them unenabled. That was a simple typographical error.

#### **D. Samsung Has Waived the Specific Arguments it Raises.**

Samsung’s main arguments on appeal concern (1) the adequacy of the motivation to combine Goodnick and Taubenblatt and (2) the interpretation of the Oxide-of-Titanium Claims relative to their base claims. However, Samsung did not specifically identify either issue in its notices of appeal, as required by 37 C.F.R. § 90.2(a)(3)(ii). A notice of the appeal *itself* “must provide sufficient

information to allow the Director to determine whether to ... intervene,” as the Director cannot practically read every FWD and appellant brief in detail to make that determination. *Id.* Samsung’s vague and general notices of appeal are counter to the rule’s requirements and purpose. Samsung has therefore waived its specific arguments. *See, e.g., Durango Assocs., Inc. v. Reflange, Inc.*, 912 F.2d 1423, 1425 (Fed. Cir. 1990) (issues not sufficiently identified in notice of appeal are waived).

## VI. CONCLUSION

The Board’s FWDs should be affirmed for all claims except claims 18 and 26-29 in IPR2020-01206.

Respectfully submitted,

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**CERTIFICATE OF COMPLIANCE  
UNDER FEDERAL RULE OF APPELLATE PROCEDURE 32(g)(1)  
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