

United States Court of Appeals for the Federal Circuit

00-1285

AFG INDUSTRIES, INC. and ASAHI GLASS COMPANY, LTD.,

Plaintiffs-Appellants,

v.

CARDINAL IG COMPANY, INC. and ANDERSEN WINDOWS, INC.,

Defendants-Appellees.

Richard D. Kelly, Oblon, Spivak, McClelland, Maier & Neustadt, P.C., of Arlington, Virginia, argued for plaintiffs-appellants. With him on the brief were Stephen G. Baxter, William T. Enos, Andrew M. Ollis, and Mandy M. Petrocelli.

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Appealed from: United States District Court for the Eastern District of Tennessee

Judge Thomas Gray Hull

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DECIDED: February 6, 2001

Before MICHEL, LOURIE, and BRYSON, Circuit Judges.

MICHEL, Circuit Judge.

This is a patent infringement case. AFG Industries, Inc. and Asahi Glass Co. (collectively, "AFG") appeal from the February 25, 2000 order of the United States District Court for the Eastern District of Tennessee granting summary judgment of noninfringement in favor of Cardinal IG Company, Inc. ("Cardinal"). On March 23, 2000, AFG filed a timely notice of appeal to this court. We have exclusive jurisdiction pursuant to 28 U.S.C. § 1295(a)(1). On November 2, 2000, we heard oral arguments in this case. Because we find that the district court erred by adopting a construction of the terms "layer" and "interlayer" that contradicts the manner in which these terms are used in the patent specification, and because the underlying findings of the trial court and the factual record are not sufficiently clear to resolve the infringement issue in light of our revised claim construction, we vacate the court's grant of summary judgment and remand for further proceedings.

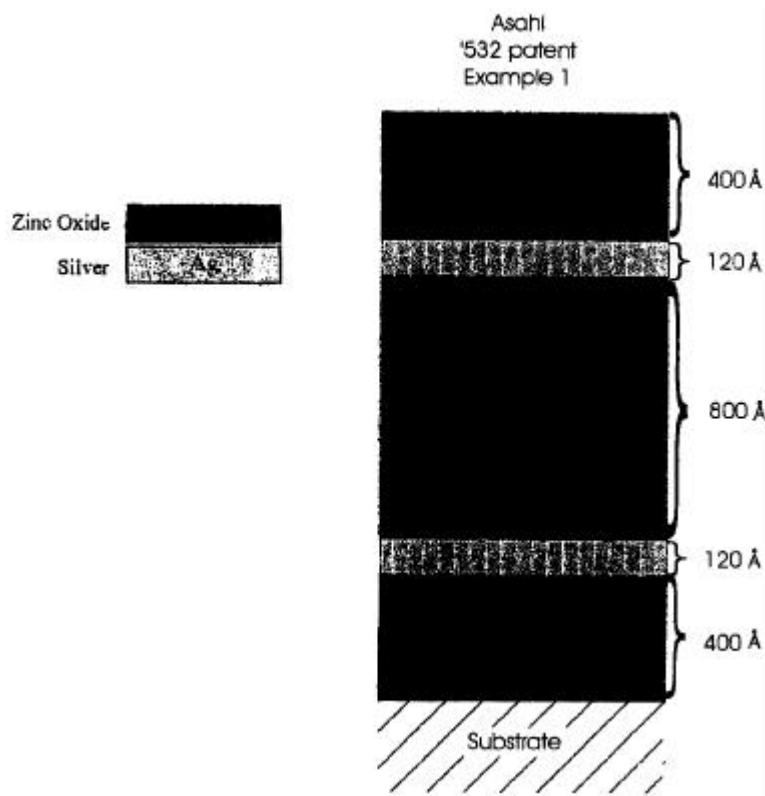
I. BACKGROUND

AFG and Cardinal are competing manufacturers of windows with "low-emissivity" coatings. Low-emissivity coatings generally consist of thin, alternating layers of metals coated onto a glass pane. When properly engineered, the metallic coatings are clear, or may have a desired color. These coatings, while permitting visible light to pass, reflect "radiant heat," or infrared radiation. Because warm objects in a home, such as lights, emit radiant heat, windows with low-emissivity coatings reflect that heat back into a home and reduce energy costs during the winter. In the summer these coatings help conserve energy by transmitting visible sunlight while blocking unwanted, invisible solar heat that readily passes through uncoated windows.

Prior to 1987, the prior art disclosed the use of thin layers of silver for coating glass. However, it was found that using a single layer of silver gave rise to undesirable qualities in the coated glass. If too thin a layer was used, the coating was not sufficiently reflective of radiant heat. If the silver layer was too thick, the window became reflective of visible light, resembling a mirror.

A. The Oyama '532 Patent

In the late 1980s, Takuji Oyama was a scientist employed by Asahi. Together with co-workers Koichi Suzuki and Mamoru Mimhashi, he was named as an inventor in a patent application filed on November 25, 1987, which eventually matured into U.S. Patent No. 4,859,532 ("the '532 patent"). The application is directed to a coating having multiple thin layers of silver, interspersed by layers of metal oxides, such as zinc oxide. By alternating layers of silver with layers of metal oxides, Oyama disclosed that the silver would become increasingly reflective of radiant heat without sacrificing its transparency to visible light. The following diagram, adapted from Cardinal's brief, illustrates the claimed coating:



In the written description of the patent application, Oyama recited that "interlayers" could be laid between the silver and metal oxide layers. Oyama disclosed that these interlayers, which are sufficiently thin to avoid substantially changing the optical properties of the silver and metal oxide layers, serve the purpose of rendering the layers more durable and increasing their adhesivity. The relevant part of the written description states:

For the purpose of improving the adhesion or durability of the coating layers, an interlayer having a thickness not to substantially affect the optical properties may be inserted at the interface with the substrate or at the interface between adjacent layers or at the interface with air.

'532 patent, col. 4, ll. 63-68. Oyama's application provides eight examples of low-emissivity coatings. None of these examples recite the use of interlayers.

Oyama's initial application contained five claims. Claim 4 of the application, which was allowed without amendment, issued as claim 1 of the '532 patent. Claim 1 of the '532 patent recites a

coating "composed of" five alternating layers of zinc oxide ("ZnO") and silver ("Ag"), with no reference to interlayers. The claim, in full, reads:

1. A transparent laminated product comprising a transparent substrate and a 5-layered transparent coating composed of a first ZnO layer formed on the substrate, a second Ag layer formed on the first layer, a third ZnO layer formed on the second layer, a fourth Ag layer formed on the third layer and a fifth ZnO layer formed on the fourth layer, and having a visible ray transmission of at least 60%, wherein the thickness of each Ag layer is from 60 to 250Å.

Oyama cancelled the four other claims of his application after they were twice rejected by the PTO examiner. The cancelled claims, like issued claim 1, disclosed a coating "composed of" multiple metallic layers, but recited the use of a "transparent oxide" rather than specifying the use of zinc oxide. The examiner rejected these broader claims in light of the prior art.

AFG and Asahi are joint owners by assignment of the '532 patent.

B. Cardinal's Accused Products

Cardinal's low-emissivity coatings contain layers of zinc oxide and silver, although in some of Cardinal's products, multiple deposits of zinc oxide are applied sequentially on top of each other, with no intervening layers of silver. Some of the layers in Cardinal's products, moreover, are separated by thin deposits of titanium dioxide, referred to by Cardinal as "barrier" layers. And, some of Cardinal's accused products have an "overcoat" or "top coat" of a thin deposit of silicon nitride or zinc oxide on top of the other layers of the coating.

Cardinal applies its barrier layers in the following manner. After first depositing a layer of zinc oxide, Cardinal "sputters" a layer of silver onto the zinc oxide in a nonreactive argon atmosphere. Cardinal thereafter applies a relatively thin deposit of titanium metal on top of the silver, again in a nonreactive argon atmosphere. Zinc oxide is then deposited on the titanium layer in a reactive atmosphere containing oxygen. This causes the titanium to oxidize, forming titanium dioxide. Were the titanium not present, the silver layer would be exposed to the reactive atmosphere and would itself be oxidized, rendering the silver black and the product unacceptable for sale. Elemental analyses of the different regions of Cardinal's accused coatings indicate that silver and zinc oxide molecules can become incorporated into the relatively thin titanium dioxide barriers. The remainder of this opinion will not distinguish between titanium, titanium oxide, and titanium dioxide.

AFG argues that Cardinal's products infringe claim 1 of the '532 patent. AFG argues that the "barrier layers" in Cardinal's products are the same as the "interlayers" disclosed in the patent, and that the language of its claim does not exclude such interlayers. AFG also argues that its claim reads on Cardinal's accused products containing "top coats."

C. The District Court Litigation

On May 23, 1996, AFG sued Cardinal and Andersen Windows, Inc. for patent infringement in the Eastern District of Tennessee. Cardinal and Andersen counterclaimed for a declaratory judgment that the '532 patent is invalid. On September 13, 1996, the district court severed and stayed the action against Andersen. On January 13-14, 1998, the court held hearings in accordance with Markman v. Westview Instruments, Inc., 517 U.S. 370 (1996), to construe

disputed claim terms of the '532 patent and to resolve pending summary judgment motions. On April 7, 1998, the district court issued an order, without an express construction of the disputed claim terms, granting Cardinal's motion for summary judgment of noninfringement, and dismissing Cardinal's counterclaim as moot.

On May 7, 1998, AFG filed a notice of appeal with this court. On January 5, 1999, we vacated the district court's judgment of noninfringement, and remanded the case, directing the trial court to set forth an explicit claim construction.

On April 9, 1999, the district court issued an order directing the parties to submit further briefing on claim construction. On February 25, 2000, the court issued a memorandum opinion construing the terms "layer" and "interlayer," and granting summary judgment of noninfringement in favor of Cardinal.

II. DISCUSSION

A. Standard of Review

Grants of summary judgment are reviewed *de novo*. Mark I Mktg. Corp. v. R.R. Donnelly & Sons Co., 66 F.3d 285, 289, 36 USPQ2d 1905, 1098 (Fed. Cir. 1995). On appeal from a grant of summary judgment, we independently evaluate the evidence to determine whether there is a genuine issue of material fact and, if there is not, whether the party that moved for summary judgment is entitled to judgment on those facts. Hormone Research Found., Inc. v. Genentech, Inc., 904 F.2d 1558, 1562, 15 USPQ2d 1039, 1042 (Fed. Cir. 1990). We draw all justifiable inferences in favor of the party opposing summary judgment. Anderson v. Liberty Lobby, Inc., 477 U.S. 242, 255 (1986).

Claim interpretation is a matter of law that is also reviewed *de novo*. Cybor Corp. v. FAS Techs., Inc., 138 F.3d 1448, 1456, 46 USPQ2d 1169, 1174 (Fed. Cir. 1998) (en banc).

A patent infringement analysis entails two steps: first, determining the meaning and scope of the patent claims asserted to be infringed, and second, comparing the properly construed claims to the device accused of infringing. Moore U.S.A., Inc. v. Standard Register Co., 229 F.3d 1091, 1105, 56 USPQ2d 1225 (Fed. Cir. 2000).

B. Claim Construction

1. Can the Claimed Coating "Composed of" Five Layers Read on a Device Containing Interlayers in Addition to Five Metallic Layers?

Cardinal argues that AFG's patent claim only reads upon coatings containing five metallic layers, and does not cover coatings that contain other layers or interlayers. Cardinal notes that claim 1 of the '532 patent recites a coating "composed of" five alternating metallic layers. Cardinal argues that "composed of" is a closed transition phrase, and therefore that this claim is limited to a coating containing five, and only five, layers of zinc oxide and silver. Cardinal points out that its accused windows have coatings that contain a thin deposit of titanium dioxide in addition to other layers of silver and zinc oxide, and thus contends that its coatings cannot infringe AFG's claim.

We refer to claim terms like "composed of" as "transition phrases." When a claim uses an

"open" transition phrase, its scope may cover devices that employ additional, unrecited elements. See Moleculon Research Corp. v. CBS, Inc., 793 F.2d 1261, 1271, 229 USPQ 805, 812 (Fed. Cir. 1986). We have consistently held that the word "comprising" is an open transition phrase. See id.; see also Elkay Mfg. Co. v. Ebco Mfg. Co., 192 F.3d 973, 977, 52 USPQ2d 1109, 1112 (Fed. Cir. 1999). In contrast, "closed" transition phrases such as "consisting of" are understood to exclude any elements, steps, or ingredients not specified in the claim. See PPG Indus. v. Guardian Indus. Corp., 156 F.3d 1351, 1354, 48 USPQ2d 1351, 1354 (Fed. Cir. 1998); see also Ex parte Davis, 80 USPQ 448, 449-50 (Pat. Off. Bd. App. 1949).

We identify little precedent defining the term "composed of." In 1942, the Court of Customs and Patent Appeals stated that "'composed of' should be regarded as synonymous with 'consisting of.'" In re Bertsch, 132 F.2d 1014, 56 USPQ 379 (CCPA 1942). The CCPA qualified this statement, however, by remarking that "the words 'composed of' may under certain circumstances be given, in patent law, a broader meaning than 'consisting of.'" Id. In the decades since the CCPA set forth this rather equivocal characterization of "composed of," this transition phrase appears to have acquired a meaning somewhat more expansive than "consisting of." The Manual of Patent Examining Procedure ("MPEP"), for example, contrasts "composed of" with "consisting of," and states that "transition phrases such as 'composed of' . . . must be interpreted in light of the specification to determine whether open or closed claim language is intended." MPEP § 2111.03 (7th ed. rev.1 Feb. 2000). While we owe no deference to the authors of the MPEP regarding the definition of claim terms, and we decline to assign such a broad and flexible meaning to this term, we do agree based on the specification and other evidence before us that the term "composed of" in this case is not completely closed. Rather, we think that "composed of" in this case should be interpreted in the same manner as "consisting essentially of." Under this approach, the transition phrase "composed of" "excludes ingredients that would materially affect the basic and novel characteristics of the claimed composition." Atlas Powder Co. v. E.I. du Pont de Nemours & Co., 750 F.2d 1569, 1574, 224 USPQ 409, 412 (Fed. Cir. 1984). The phrase is open to "unlisted ingredients that do not materially affect the basic and novel properties of the invention." PPG, 156 F.3d at 1354, 48 USPQ2d at 1354.

The invention in this case is a product comprising a coating, which is itself "composed of" various layers. It appears, from a reading of the patent specification and from the testimony elicited during the Markman hearing, that interlayers are important to facilitate the process of manufacturing the claimed coatings, but are not themselves significant in the final, claimed product. The patent specification states that interlayers, although optically insignificant, are useful to protect the explicitly claimed layers: "For the purpose of improving the adhesion or durability of the coating layers, an interlayer having a thickness not to substantially affect the optical properties may be inserted at the interface with the substrate or at the interface between adjacent layers or at the interface with air." Col. 4, ll. 63-68.

Moreover, the parties presented essentially undisputed evidence that persons of ordinary skill in the art understand that interlayers (or "barrier layers") are routinely, and often necessarily, present in low-emissivity coatings that contain silver. The testimony at the Markman hearing makes clear that barrier layers may be vitally important in the process of producing low-emissivity coatings, but that in the final product (as is claimed in this case), they may be disregarded. For example, during the Markman hearing, Cardinal presented live testimony of its president, Roger O'Shaughnessy, who appears to be a person of ordinary skill in the art. On direct examination, O'Shaughnessy stated that Cardinal's products would be "black and

totally unusable" if titanium barrier layers are not applied:

My understanding is that when the silver comes out of a zone which has just sputtered the silver and if no titanium metal were applied, then the resulting zinc oxide would be formed on the silver and would literally ruin the silver; so the coating comes out extremely ugly. It's very black and totally unusable.

AFG also presented deposition testimony of O'Shaughnessy. When asked whether a Cardinal coating referred to in an internal document contained barrier layers in addition to other recited layers, O'Shaughnessy replied:

A. Absolutely. We can't run this product without barrier layers. I mean, it just goes whacko. It's impossible to --

Q. Okay, but it's not referred to in the, in the document; is that correct?

A. No, it's not, nor is the top layer broken into its components; so I think, again, someone is just communicating fundamental basic layer structures; oxide, metal, oxide, metal, without going into the detail of the actual layers that exist.

Q. But even though it's not specified, it's your understanding that a barrier layer is included?

A. Absolutely. That may be the source of the confusion here. It -- because we can't run without it, we just always know it's there, so internally everybody just assumes the barrier is there.

O'Shaughnessy's testimony further indicates that when describing their layered coatings, Cardinal personnel generally omit reference to the barrier layers. During the Markman hearing, O'Shaughnessy referred to a Cardinal product sheet that had been written for its production line operators and that contained the following description of one of its coatings:

E5 Lo E has a shading coefficient of 5.5

This coating is made up of 5 layers:

- 1) zinc oxide
- 2) metal (Silver, ti barrier)
- 3) zinc oxide
- 4) metal (Silver, ti barrier)
- 5) top oxide (zinc and ti)

O'Shaughnessy acknowledged that this internal Cardinal document describes the coating as a "5 layer coating," despite the presence of several barrier layers in addition to the five primary metallic layers. In his deposition, O'Shaughnessy testified, moreover, that he generally omits reference to the barrier layers when describing coatings. He testified: "That's pretty common to

drop the reference [to barrier layers]. It just gets sort of clumsy to put them in. . . . I would always assume that the barriers are in there."

The patent specification and the testimony presented during the Markman hearing indicate that the importance of the interlayers (or barrier layers) arises only in the process of fabricating the coatings, and that once the claimed product is formed, the presence of the interlayers may be insignificant. It appears that the interlayers may be an artifact of the manufacturing process, rather than a material component of the claimed coating itself. Whether they are, indeed, immaterial in the final product is a question of fact. See PPG, 156 F.3d at 1357, 48 USPQ2d at 1357 (determining that a claim to a glass product could read on the accused glass containing iron sulfide, and stating that it is the province of the jury to determine whether the iron sulfide had a material effect on the basic and novel characteristics of the glass). Thus, in light of the specification and of the essentially undisputed testimony of persons of ordinary skill, we think it is reasonably clear that the claimed coating may include interlayers, insofar as they "do not materially affect the basic and novel properties of the invention." PPG, 156 F.3d at 1354, 48 USPQ2d at 1354. We set forth a more explicit definition of "layer" and "interlayer" below.

2. What is the Proper Construction of the Term "Layer"?

A key issue in this case is how to distinguish between "layers" and "interlayers." It is undisputed that Cardinal's accused products contain deposits of titanium in addition to layers of silver and zinc oxide. Determining whether Cardinal's products infringe the patent requires ascertaining whether these titanium deposits constitute "interlayers," as would be covered by the patent claim, or additional "layers," which would not. Accordingly, it is necessary to define both "layer" and "interlayer" to determine how to categorize the titanium deposits.

a. the trial court's interpretation of "layer" and "interlayer"

The trial court noted that the patentee did not set forth an explicit definition of "layer" in the patent, and thus the court sought to construe "layer" according to its ordinary meaning. To do so, the court selected the definition of the term "layer" appearing in Webster's Third New International Dictionary: "one thickness, course, or fold laid or lying over another...." From the same dictionary, the trial court adopted the following definition of "interlayer": "a layer placed between other layers." The trial court appears to have retreated from adopting these definitions as a final claim construction, for it stated that these definitions were merely a "starting point." The court went on to quote our statement that "[i]ndiscriminate reliance on definitions found in dictionaries can often produce absurd results One need not arbitrarily pick and choose from the various accepted definitions of a word to decide which meaning was intended as the word is used in a given claim." Renishaw PLC v. Marposs Societa' Per Azioni, 158 F.3d 1243, 1250, 48 USPQ2d 1117, 1122 (Fed. Cir. 1998). Nonetheless, the trial court offered no other construction for these disputed claim terms. It appears from the remainder of the court's order that it departed from the definitions set forth in the dictionary it quoted, but we cannot discern exactly what interpretation of "layer" and "interlayer" the court settled upon. It is critical for trial courts to set forth an express construction of the material claim terms in dispute, in part because the claim construction becomes the basis of the jury instructions, should the case go to trial. See IPPV Enters., LLC v. Echostar Communications Corp., 106 F. Supp.2d 595, 601 (D. Del. 2000). It is also the necessary foundation of meaningful appellate review.

This court has repeatedly cautioned against using non-scientific dictionaries for defining technical words. See Anderson v. Int'l Eng'g & Mfg., Inc., 160 F.3d 1345, 1348-49, 48 USPQ2d 1631, 1634 (Fed. Cir. 1998) ("[D]ictionary definitions of ordinary words are rarely dispositive of their meanings in a technological context. A word describing patented technology takes its definition from the context in which it was used by the inventor."); Hoechst Celanese Corp. v. BP Chems., Ltd., 78 F.3d 1575, 1580, 38 USPQ2d 1126, 1130 (Fed. Cir. 1996) ("[A] general definition is secondary to the specific meaning of a technical term as it is used and understood in a particular technical field."). This case provides a good example of why definitions from general usage dictionaries may fail to provide satisfactory constructions of technical claim terms in dispute.

First, the dictionary definitions apparently adopted by the trial court erase the distinction set forth in the written description of the patent between "layer" and "interlayer." The written description clearly states that "interlayers" have different physical attributes than "layers," because, being relatively thin, they do not "substantially affect the optical properties" of the other layers. This statement in the written description, along with the remainder of the specification, provides the scientific and technical context for interpreting the meaning of the terms "layer" and "interlayer." A trial court, when construing a term of art, must define the term in a manner consistent with the scientific and technical context in which it is used in the patent. Only when the context is unclear, or it appears that the term is not being used in a technical manner, should the trial court rely upon a general purpose dictionary for construing the term. In the present case, the dictionary definition adopted for the term "interlayer" (i.e., a "layer placed between other layers") contradicts the meaning of the term "interlayer" as it is used in the technological context of the patent, as the dictionary definition does not account for the insignificant optical effect of the interlayers.

Second, the dictionary definitions adopted by the trial court are inconsistent with essentially undisputed testimony during the Markman hearing as to how persons of ordinary skill in the art would interpret the terms "layer" and "interlayer." As described above, AFG presented deposition testimony of Mr. O'Shaughnessy during the Markman hearing, who referred to a description of a Cardinal coating set forth in internal product literature. When asked whether the product also contained barrier layers in addition to the explicitly recited layers, O'Shaughnessy replied: "Absolutely. We can't run this product without barrier layers. I mean, it just goes whacko." He continued, stating that "because we can't run without [the barrier layer], we just always know it's there, so internally everybody just assumes the barrier is there." This testimony shows that a person of ordinary skill would understand that there is a substantive difference between "layers" and "interlayers" or "barrier layers," and that the claim construction in this case should reflect this distinction. This distinction is highlighted in other testimony elicited from O'Shaughnessy noted above.

Arguably, the brevity of the description of "interlayers" set forth in the patent may have created some ambiguity as to whether the construction of the term "layer" should reflect a distinction between "layers" and "interlayers." However, the testimony during the Markman hearing by persons of ordinary skill in the art, such as O'Shaughnessy, serves to clarify that this distinction is material, and that it should be reflected in the construction of the term "layer."

The facts of this case are essentially the inverse of those we discussed in Vitronics Corp. v. Conceptor, Inc., 90 F.3d 1576, 39 USPQ2d 1573 (Fed. Cir. 1996). In Vitronics, the district court construed the claim term "solder reflow temperature" to mean "liquidus temperature," based in part on testimony that persons of ordinary skill in the art would so define the claim

term. On appeal, we determined that the patent specification established with reasonable clarity that the claim term "solder reflow temperature" should be defined to be the "peak reflow temperature" recited in the written description, rather than the "liquidus temperature." In light of our conclusion that the patent specification itself had sufficiently defined the term "solder reflow temperature," we ruled that the district court erred in relying upon expert testimony that contradicted the intrinsic evidence. Expert testimony, we stated, "may not be used to vary or contradict the claim language." *Id.* at 1584, 39 USPQ2d at 1577. Whereas in *Vitronics*, the expert testimony contradicted the meaning of "solder reflow temperature" set forth in the specification, in the present case, O'Shaughnessy's testimony explains, corroborates, and reinforces the distinction recited in the written description between "layer" and "interlayer."

As we explained in *Pitney Bowes, Inc. v. Hewlett-Packard Co.*, 182 F.3d 1298, 1309, 51 USPQ2d 1161, 1168 (Fed. Cir. 1999), "it is entirely appropriate, perhaps even preferable, for a court to consult trustworthy extrinsic evidence to ensure that the claim construction it is tending to from the patent file is not inconsistent with clearly expressed, plainly apposite, and widely held understandings in the pertinent technical field." Moreover, we are reminded of the potential value of scientific testimony during claim construction hearings by the early statement of the Supreme Court that where the claims or specification "contain technical terms or terms of art the court may hear the testimony of scientific witnesses to aid the court in coming to a correct conclusion." *Seymour v. Osborne*, 78 U.S. 516, 546 (1870). The Court continued, stating that "the testimony of scientific witnesses is indispensable to a correct understanding" of the meaning of disputed claim terms, and that "it would undoubtedly be error in the court to reject the testimony." *Id.*

This case presents a good example of how extrinsic evidence can and should be used to inform a court's claim construction, and how failure to take into account the testimony of persons of ordinary skill in the art may constitute reversible error. O'Shaughnessy's essentially undisputed testimony appears to represent "trustworthy" and "clearly expressed, plainly apposite" evidence that persons of ordinary skill in the art do distinguish between layers and interlayers. *Pitney Bowes*, 182 F.3d at 1309, 51 USPQ2d at 1168. This testimony reinforces the distinction drawn in the written description of the '532 patent between these two terms.

We conclude that the trial court erred by adopting a claim construction that does not distinguish between layers and interlayers. The primary error in the trial court's claim construction is that it eliminates the distinction between these terms that is set forth in the written description of the patent itself. It is also significant that the court's claim construction failed to take into account the testimony of O'Shaughnessy and other witnesses at the *Markman* hearing that further reinforced the distinction between "layers" and "interlayers." To the extent that the brief statement in the specification of the '532 patent may have been vague or ambiguous as to whether the claim term "layer" should be defined differently than "interlayers," the trial court should have considered the testimony presented in the *Markman* hearing and set forth a definition of "layer" that distinguishes between "layers" and "interlayers."

b. this court's construction of "layer" and "interlayer"

The parties' proposed definitions for the term "layer" are not much in disagreement. AFG asserts that a layer is "a thickness of a material of uniform chemical composition." Although Cardinal now seeks a simple affirmance of the trial court's construction, it originally proposed that a layer should be "a thickness of a material of uniform chemical composition bounded by

a material of a different chemical composition." Under Cardinal's original approach, two adjacent deposits of the same material would consist of only one "layer."

Cardinal appears to have advocated applying this further limitation so that a prior art patent, U.S. Patent No. 4,943,484 to Goodman (that appears to disclose sequential deposits of zinc oxide/silver/zinc oxide/zinc oxide/silver/zinc oxide), would constitute a five layer coating and thus anticipate the asserted claim. However, the specification of the '532 patent nowhere limits the term "layer" to a deposit bounded by a material of a different chemical composition. We thus decline to include such a limitation in our construction of the term "layer."

The parties both suggest that to constitute a "layer," a deposit must have a "uniform" chemical composition. AFG suggests that because the titanium deposits in Cardinal's products appear to have incorporated silver and zinc oxide molecules from adjacent layers, that the titanium deposit cannot itself constitute a layer. However, focusing on the chemical uniformity of a deposit, rather than its optical properties, constitutes a departure from the disclosures and teachings of the patent. Nowhere does the patent refer to chemical "uniformity" as a characteristic of a layer or interlayer. While we do not doubt that a metallic deposit must be substantially uniform to constitute a "layer," we do not think that the incorporation of trace amounts of silver or zinc oxide into a titanium deposit would disqualify that deposit from constituting a layer. Accordingly, we hold that the chemical composition of a layer must only be "substantially uniform," rather than "uniform."

The definition of "layer," as discussed above, must also distinguish between "layers" and "interlayers." The written description of the '532 patent distinguishes between these two terms by stating that "interlayers" have "a thickness not to substantially affect the optical properties." Consistent with the specification, we conclude that "layer" should be interpreted as: "a thickness of material of substantially uniform chemical composition, but excluding interlayers having a thickness not to substantially affect the optical properties of the coating." When determining whether a deposit is optically significant, the focus should be on whether the thickness and composition of the material itself is optically significant, rather than whether the absence of that material would lead to oxidation and discoloration of adjacent layers. Moreover, we make no determination as to whether a chemical compound that has been deposited in multiple separate, sequential applications, without intervening layers or interlayers, constitutes a single "layer." This is a matter for the trial court to resolve in a manner consistent with our claim construction.

3. How should the remaining disputed claim terms be construed?

The parties contest the meaning of several other terms found in claim 1 of the '532 patent. Following is the court's resolution of these remaining terms.

a. "comprising"

The parties dispute whether the asserted claim reads on a five-layer coating that is covered by an additional "top coat" or "overcoat," which may be a thin deposit used to improve the durability of the coating. AFG notes that the claim recites a "transparent laminated product comprising" a substrate and a coating, and argues that this claim is open to the presence of additional elements, such as a top coat.

Although neither party has offered a definition of a "top coat," we note that AFG's expert,

Professor Roy Gordon, testified during the Markman hearing as to how one skilled in the art would understand the top coats. He stated: "You can put additional layers on top of the five layered transparent coating for the purpose of protecting them, and that's commonly done in the industry." Similarly, Robert Bond, the Operations Manager at one of Cardinal's facilities, testified for Cardinal that he found that applying a thin layer of zinc oxide on top of their coatings rendered them "remarkably hard" and chemically resistant to acidic washes. In light of the testimony offered by both parties on this subject, we think that a chemical deposit on top of a coating that is primarily used to protect the stack would constitute a "top coat," and that a product with such a top coat would fall within the scope of claim 1 of the '532 patent. Because the parties did not focus on this issue in their briefing, and the trial court did not directly address it, the trial court may choose to set forth additional criteria on remand for determining what constitutes a "top coat," as distinguished from a "layer."

b. "formed on"

The parties dispute whether the claim language requires that each successive layer be "formed on" the prior layer in such a way that nothing is interposed between each layer. As described above, however, the court has determined that the claim language and the specification permit the presence of interlayers between layers. Notably, the claim does not state that each layer is "formed directly on" the preceding layer. Accordingly, we determine that "formed on" does not mean "directly in contact with."

C. Summary Judgment

It appears to be undisputed that at least some of Cardinal's accused products include titanium deposits that are 50 angstroms thick, or more. In its findings, the trial court referred to testimony from the summary judgment hearing by AFG's expert, Roy Gordon, that prior art coatings had interlayers that were 5 or 6 angstroms thick, and that these interlayers were "very tiny amounts of material which have no significant effect on the optical properties." The trial court appears to have inferred from this statement that AFG's position is that materials substantially thicker than five or six angstroms would be optically significant. Apparently based on this assumption, the trial court concluded that "the thickness of the 20 to 55 angstroms of titanium dioxide in the various Cardinal LoE2 products does not disqualify the titanium as a 'layer.'"

The record is unclear regarding AFG's position as to what constitutes an optically significant thickness of titanium. We conclude, however, that the trial court's appraisal of AFG's position is incorrect. While acknowledging that a thickness of 100 angstroms would probably be optically significant, Gordon asserted that the prior art disclosed that thicknesses of 20 angstroms would not be optically significant. In his second declaration, Gordon also refers to U.S. Patent No. 5,296,302, which discloses that thicknesses up to 40 angstroms might not significantly affect a coating's optical properties. Based on these statements, we conclude that the trial court impermissibly assumed that AFG's position is that thicknesses substantially greater than 5 or 6 angstroms would be optically significant.

The trial court, however, may be correct that the titanium deposits in Cardinal's products are optically significant. Of particular interest is a statement in Gordon's second declaration that "[a] layer of titanium dioxide with a thickness of 35Å substantially affects the optical properties and, therefore, is properly counted as a 'layer.'" This statement, however, was not addressed during the summary judgment hearing, and it is unclear how the context of this statement

should affect its interpretation, and whether this statement can be relied upon as a statement of AFG's position regarding whether Cardinal's titanium deposits constitute optically significant layers. As an appellate court reviewing the record, we do not feel comfortable relying upon this statement, which was not a focus of the proceedings below, as the primary grounds for affirming the trial court's grant of summary judgment of noninfringement.

On the basis of the trial court's findings and the factual record before us, we cannot determine with certainty whether a genuine issue of material fact remains as to Cardinal's motion for summary judgment of non-infringement, particularly in light of our revised claim construction. Accordingly, we vacate the trial court's judgment of noninfringement and remand for further proceedings consistent with this opinion.

On remand, the trial court may find that Cardinal is entitled to summary judgment, either for noninfringement or for invalidity, or both. We note that Cardinal moved at the trial court for summary judgment of invalidity of the asserted claim pursuant to 35 U.S.C. § 102 and § 103 in light of the prior art, and that the trial court did not address this motion in its February 25, 2000 order. We take no view on the merits of this motion, but note that the trial court on remand should resolve this motion to determine whether it is necessary to proceed to trial in this case. We also note that the trial court might properly grant summary judgment of non-infringement if it determines that there is no genuine dispute that Gordon's statement in his second declaration (that "[a] layer of titanium dioxide with a thickness of 35Å substantially affects the optical properties and, therefore, is properly counted as a 'layer'") establishes that the titanium deposits in Cardinal's products are sufficiently thick to be optically significant. The trial court may decide to proceed on the basis of the existing record, or it may choose to allow the parties to submit additional evidence to support their positions in light of this court's revised claim construction. Other issues, beyond those mentioned here, may be appropriate for resolution at the summary judgment stage, or at trial.

III. Conclusion

We conclude the term "composed of" should be interpreted in the same manner as "consisting essentially of," and thus that claim 1 of the '532 patent may read on coatings containing interlayers or barrier layers, insofar as they have a thickness not to substantially affect the optical properties of the coating. We find that the trial court's construction of the terms "layer" and "interlayer" improperly eliminated the distinction set forth in the written description, and corroborated by extrinsic evidence, between these two terms. We rule that the term "layer" is defined as "a thickness of material of substantially uniform chemical composition, but excluding interlayers having a thickness not to substantially affect the optical properties of the coating." Also, we define "comprising" to permit the claim to read on coatings covered with a "top coat" or "overcoat." Moreover, we conclude that "formed on" does not mean "directly in contact with."

Because we have adopted a different claim construction than that applied by the trial court, and because the record upon which the trial court based its findings and the findings themselves are unclear, we vacate the judgment of the court below and remand for further proceedings.

VACATED and REMANDED

Costs

Each party to bear its own costs.