UNITED STATES DISTRICT COURT
DISTRICT OF MASSACHUSETTS

TRUSTEES OF BOSTON UNIVERSITY, Plaintiff, v. EVERLIGHT ELECTRONICS CO., LTD., et al., Defendants.	Consolidated Civil Action No. 12-11935-PBS
TRUSTEES OF BOSTON UNIVERSITY, Plaintiff, v. EPISTAR CORPORATION, et al., Defendants.	Civil Action No. 12-12326-PBS
TRUSTEES OF BOSTON UNIVERSITY, Plaintiff, v. LITE-ON INC., et al., Defendants.	Civil Action No. 12-12330-PBS

May 20, 2015

Saris, Chief Judge.

MEMORANDUM AND ORDER

Plaintiff, Boston University (BU), has filed a motion for summary judgment alleging infringement of Claims 1, 2, 7, 9, 10, 18, and 19 of U.S. Patent No. 5,686,738 (Docket No. 1105). Defendants, Everlight Electronics Co., Ltd. (Everlight), Epistar Corporation (Epistar), and Lite-On Inc. (Lite-On), have filed a

motion for summary judgment alleging non-infringement of all asserted claims (Docket No. 1109). The Court assumes familiarity with the underlying technology. See Trustees of Boston University v. Everlight Electronics Co., Ltd., 23 F. Supp. 3d 50, 53-57 (D. Mass. 2014). After hearing, and a review of the substantial briefing, I **DENY** both motions.

DISCUSSION

I. Standard of Review

A patent owner must prove infringement by a preponderance of the evidence. S. Bravo Sys., Inc. v. Containment Techs., Corp., 96 F.3d 1372, 1376 (Fed. Cir. 1996). A defendant commits patent infringement if the accused product practices every limitation of at least one claim of the patent. Freedman Seating Co. v. Am. Seating Co., 420 F.3d 1350, 1356-57 (Fed. Cir. 2005). Having construed the claim terms at issue, the Court must apply those terms to the accused product in determining whether the plaintiff has borne its burden to show infringement. Markman v. Westview Instr., Inc., 517 U.S. 370, 374 (1996).

In deciding a case on summary judgment, the Court views the facts in the light most favorable to the non-moving party and makes all reasonable inferences in that party's favor. O'Connor v. Steeves, 994 F.2d 905, 907 (1st Cir. 1993). Summary judgment is appropriate when no genuine issue exists as to any material fact, and the moving party is entitled to judgment as a matter of law. Eli Lilly & Co. v. Barr Labs, Inc., 251 F.3d 955, 962 (Fed.

Cir. 2001). "When evaluating a motion for summary judgment, the court views the record evidence through the prism of the evidentiary standard of proof that would pertain at a trial on the merits." Id.

II. Analysis

BU alleges that certain of the defendants' products infringed claims 1, 2, 7, 9, 10, 18, and 19 of U.S. Patent No. 5,686,738 ('738 Patent). The relevant component of the Patent claims a semiconductor device containing "a non-single crystalline buffer layer...consisting essentially of gallium nitride." Docket No. 1107 at ¶ 14. After the Markman hearing, I construed the claim term "non-single crystalline" as "not monocrystalline, namely polycrystalline, amorphous or a mixture of polycrystalline or amorphous." Trustees of Boston University, 23 F. Supp. 3d at 62-63.

The primary dispute between the parties is whether the gallium nitride (GaN) buffer layer in each of the defendants' exemplar products (Exemplars) is polycrystalline and/or amorphous rather than monocrystalline. If the Exemplars' buffer layers are non-single crystalline, the Exemplars infringe the patent; if the buffer layers are monocrystalline, the Exemplars are noninfringing. Because two qualified experts disagree whether the Exemplar buffer layers consist of one crystal or multiple crystals, summary judgment is inappropriate.

A crystal is an ordered structure of atoms or molecules that

extends in all directions. Docket No. 1113, Declaration of Dr. Joan Redwing at ¶ 13, 28 (Redwing Decl.). A crystal is also known as a "grain," and a polycrystalline material contains more than one grain or crystal. Id. When individual crystals are separated at angles, the interfaces between those crystals are known as "grain boundaries." Docket No. 1191-11, Declaration of Dr. Eugene Fitzgerald in Support of Defendants' Technology Tutorial at ¶ 26 (Fitzgerald Technology Decl.); Docket No. 1191-10, Callister (see infra) at 103, G6, G10. There may be various degrees of misalignment between different crystals in polycrystalline materials. When the degree of misalignment is small, the grain boundary is known as"low-angle." Docket No. 1158-6, Supplemental Declaration of Dr. Edwin Piner at ¶ 7 (Piner Supplement). When the degree of misalignment is larger, the grain boundary is called "high-angle." Id. at ¶ 10.

Against this backdrop, BU argues that Defendants' accused products contain non-single crystalline buffer layers and therefore infringe the patent. See Docket No. 1107-3, 1107-4, Declaration of Dr. Edwin Piner at ¶ 19 (Piner Decl.). Plaintiff's expert, Dr. Edwin L. Piner, a Professor of Physics and Materials Science, Engineering and Commercialization at Texas State University, opined that the presence of "grain boundaries" in the GaN buffer layers in Epistar's Exemplars means that those layers are polycrystalline. Piner Supplement at ¶¶ 7, 8, 10. In arriving at this conclusion, Dr. Piner conducted tests on the Exemplars to determine the crystallinity of their buffer layers. First, he

analyzed a transmission electron microscopy ("TEM") cross-sectional image of the Exemplars, generated by sending a highly focused beam of accelerated electrons through the material in question. Piner Decl. at ¶ 46. Next, he used a Fourier transform, a mathematical function that translates spatial data into amplitudes and frequencies, to generate electron diffraction patterns of certain regions in the TEM images. Id. at ¶ 50.

Based on the TEM cross-sections, Fourier transform data, and resulting diffraction patterns, Dr. Piner concluded that the Exemplar buffer layers are polycrystalline. He first identified crystalline regions, amorphous regions, and stacking defects in the buffer layers. Piner Decl. at ¶ 27. The crystalline regions, he opined, contain areas of "varied atomic contrast," id. at ¶ 27,[1] which demonstrate the presence of grain boundaries. Dr. Piner further observed that the Exemplar diffraction patterns exhibit faint spots beside brighter spots, which is also "indicative of non-single crystallinity." Id. at ¶ 28. Finally, based on the TEM diffraction patterns and atomic contrast levels, Dr. Piner opined that the Exemplar buffer layers contain both polycrystalline and amorphous regions, and that such regions are "non-single crystalline" as claimed by the '738 Patent. Id. at ¶ 54-55.

Dr. Piner identified both low- and high-angle grain

[1] To the lay eye, these regions resemble indistinguishable "cloud illusions." Joni Mitchell, "Both Sides Now" (Reprise Records 1969).

boundaries in the Exemplar buffer layers. In so concluding, Dr. Piner relied on a learned treatise, Materials Science and Engineering, An Introduction, 8th ed., William D. Callister, Jr., et al. (2010) (Callister), which states:

> Within the [grain] boundary region, which is probably just several atom distances wide, there is some atomic mismatch in a transition from the crystalline orientation of one grain to that of an adjacent one...When this orientation mismatch is slight, on the order of a few degrees, then the term small- (or low-) angle grain boundary is used. These boundaries can be described in terms of dislocation arrays...Other possible interfacial defects include stacking faults...

(p. 72). Dr. Piner first stated that he observed "low angle grain boundaries" in each of the Exemplar buffer layers. The lattice fringe[2] in those layers, he explained, contained adjacent grain misorientations of between two and two-and-a-half degrees. Piner Supplement at ¶¶ 14, 15, 17, 19, 21. Based on the TEM cross-section images, Dr. Piner also concluded that the Exemplar buffer layers are highly defective and comprised of many distinct "higher-angle [grain] boundaries." Id. at ¶ 31.

In contrast, Defendants contend that the TEM diffraction patterns reveal the Exemplar buffer layers to be single crystalline. Defendant's expert, Dr. Eugene Fitzgerald, a professor of Material Engineering at MIT, concluded that what Dr. Piner believed to be low-angle grain boundaries in a

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[2] Lattice fringe occurs in a polycrystalline material when one lattice, or crystal, is rotated at a different angle from an adjacent lattice. See Docket No. 945-3 at 24:4-8. Tracing a lattice fringe can identify grain boundaries between adjacent grains in a polycrystalline material. Docket No. 1158-6, Piner Supplemental Decl. at ¶ 12.

polycrystalline material were in fact merely defects in a monocrystalline material. Docket No. 1166, Declaration of Dr. Fitzgerald at ¶¶ 8, 10 (Fitzgerald Decl.). Dr. Fitzgerald stated,

> I do not see a two-degree grain boundary in Exhibit 2. Even if there were, a low angle grain boundary would not classify a layer as polycrystalline. Researchers working in the area of gallium nitride recognize that monocrystalline (or single crystalline) gallium nitride layers may include defects such as this.

Id. at ¶ 10. Dr. Fitzgerald also disputes that certain "blurry" areas in the TEM images are amorphous. Id. at ¶ 12. For one thing, says Dr. Fitzgerald, Dr. Piner cites no basis for concluding that these areas are amorphous. Id. For another, both Dr. Fitzgerald and Defendants' other expert, Dr. Joan Redwing, conclude that the Exemplar buffer layers are recrystallized at temperatures too high for the layers to remain amorphous. Docket No. 1191-3, Fitzgerald Deposition at pp. 37, 39-40, 58; Redwing Decl. at ¶ 40. Finally, Dr. Fitzgerald opined that the diffraction patterns in TEM images of the Exemplar buffer layers are consistent with a monocrystalline material. Fitzgerald Decl. at ¶ 13. "The accepted way of determining crystallinity of a sample at this scale," he noted, "is by analyzing the TEM diffraction pattern." Id. at ¶ 18.

The main expert dispute thus appears to be whether low-angle grain boundaries necessarily signify that a buffer layer is polycrystalline or whether grain boundaries can also exist in a single crystal. Both experts agree that all polycrystalline

materials contain grain boundaries. But while Dr. Piner concludes that grain boundaries are only present in polycrystalline materials, Dr. Fitzgerald opines that grain boundaries may in fact signify defects in a monocrystalline substance. It is for a jury to decide, in light of these conflicting expert opinions, whether the buffer layers in Epistar's Exemplars are monocrystalline or polycrystalline and, in turn, whether the Exemplars infringe the '738 Patent. I **DENY** both motions for summary judgment.

/s/ PATTI B. SARIS
Patti B. Saris
Chief Judge