

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

Samsung Electronics Co., Ltd.,
Petitioner,

v.

SiOnyx, LLC,
Patent Owner.

Case No. IPR2024-01431
Patent No. 11,069,737

**DECLARATION OF DR. MICHAEL LEBBY IN SUPPORT OF PETITION
FOR *INTER PARTES* REVIEW OF U.S. PATENT NO. 11,069,737**

TABLE OF CONTENTS

I.	INTRODUCTION	1
II.	BACKGROUND AND QUALIFICATIONS	1
III.	MATERIALS REVIEWED.....	9
IV.	RELEVANT LEGAL STANDARDS.....	11
V.	TECHNOLOGY BACKGROUND	14
VI.	OVERVIEW OF U.S. PATENT NO. 11,069,737	16
A.	Summary	16
B.	Prosecution History	17
C.	Level of Ordinary Skill in the Art	18
D.	Claim Construction.....	19
VII.	OVERVIEW OF THE PRIOR ART	20
A.	U.S. Patent Application Publication No. 2011/0227138 (Haddad138) (Ex-1012)	20
B.	U.S. Patent Application Publication No. 2006/0081900 (Baggenstoss) (Ex-1007).....	22
C.	International Publication No. WO 2012/122572 (Jiang) (Ex- 1008)	24
D.	U.S. Patent Application Publication No. 2012/0068289 (Alie) (Ex-1006).....	26
E.	U.S. Patent Application Publication No. 2012/0313204 (Haddad204) (Ex-1009)	28
F.	U.S. Patent Application Publication No. 2010/0006969 (Park) (Ex-1010).....	29

G.	U.S. Patent No. 7,928,389 (Yap) (Ex-1011).....	31
VIII.	CLAIMS ANALYSIS.....	32
A.	Ground A-1: Claims 1-11, 13-16, 18-19, 22, 25, 32-42, 44-46, 48-49, 52, and 55 Are Anticipated, or at a Minimum Obvious, Based on Haddad138.....	32
1.	Claim 1.....	32
2.	Claim 2.....	40
3.	Claim 3.....	43
4.	Claim 4.....	45
5.	Claim 5.....	45
6.	Claim 6.....	45
7.	Claim 7.....	51
8.	Claim 8.....	53
9.	Claim 9.....	53
10.	Claim 10.....	53
11.	Claim 11.....	54
12.	Claim 13.....	55
13.	Claim 14.....	57
14.	Claim 15.....	59
15.	Claim 16.....	59
16.	Claim 18.....	62
17.	Claim 19.....	62
18.	Claim 22.....	63

19.	Claim 25.....	64
20.	Claim 32.....	65
21.	Claim 33.....	66
22.	Claim 34.....	66
23.	Claim 35.....	67
24.	Claim 36.....	67
25.	Claim 37.....	67
26.	Claim 38.....	67
27.	Claim 39.....	68
28.	Claim 40.....	68
29.	Claim 41.....	68
30.	Claim 42.....	68
31.	Claim 44.....	68
32.	Claim 45.....	69
33.	Claim 46.....	69
34.	Claim 48.....	69
35.	Claim 49.....	70
36.	Claim 52.....	70
37.	Claim 55.....	70
B.	Ground A-2: Claims 1, 12-13, 21, 24, 43-44, 51, and 54 Are Obvious Based on Haddad138 and Baggenstoss.....	71
1.	Claim 1.....	71
2.	Claim 12.....	73

3.	Claim 13.....	75
4.	Claim 21.....	77
5.	Claim 24.....	78
6.	Claim 43.....	80
7.	Claim 44.....	80
8.	Claim 51.....	81
9.	Claim 54.....	81
10.	Motivation to combine Haddad138 and Baggenstoss.....	81
C.	Ground A-3: Claims 16, 32-42, 44-46, 48-49, 52, and 55 Are Obvious Based on Haddad138 and Jiang.....	83
D.	Ground A-4: Claims 17, 20, 23, 47, 50, and 53 Are Obvious Based on Haddad138 and Alie.....	86
1.	Claim 17.....	86
2.	Claim 20.....	87
3.	Claim 23.....	88
4.	Claim 47.....	89
5.	Claim 50.....	89
6.	Claim 53.....	90
7.	Motivation to combine Haddad138 and Alie.....	90
E.	Ground A-5: Claims 25 and 55 Are Obvious Based on Haddad138 and Haddad204.....	92
1.	Claim 25.....	92
2.	Claim 55.....	95

F.	Ground A-6: Claims 25 and 55 Are Obvious Based on Haddad138 and Park.....	95
1.	Claim 25.....	95
2.	Claim 55.....	98
G.	Ground B-1: Claims 26, 28-29, and 31 Are Anticipated, or at a Minimum Obvious, Based on Yap.....	98
1.	Claim 26.....	98
2.	Claim 28.....	103
3.	Claim 29.....	103
4.	Claim 31.....	104
H.	Ground B-2: Claim 27 Is Obvious Based on Yap and Alie.....	105
1.	Claim 27.....	105
IX.	Evidence of Non-obviousness.....	108
X.	Conclusion.....	108

I. INTRODUCTION

1. I, Michael Lebby, declare as follows.

2. I have been retained as a technical consultant on behalf of Samsung Electronics Co., Ltd. (“Samsung” or “Petitioner”), which I understand to be the petitioner in the present proceeding. I have been asked to consider whether the references listed as Exhibits 1006-1012 below disclose or render obvious the limitations recited in claims 1-29 and 31-55 of U.S. Patent No. 11,069,737 (Ex-1001, “’737 patent”). I have also been asked to consider the state of the art and the “prior art,” i.e., references, available before the time of the alleged invention of the ’737 patent. My opinions are provided in this declaration.

3. I am being compensated at my standard consulting rate for my time. My compensation is in no way contingent on the results of these or any other proceedings relating to the ’737 patent.

II. BACKGROUND AND QUALIFICATIONS

4. A description of my professional background and qualifications is provided below. An additional account of my work experience and qualifications is included in my *curriculum vitae*, which is Ex-1005 (“CV”).

5. I am currently the CEO and CTO at GenusTechnik Inc., which provides consulting services in areas that include image sensors, photonics, optoelectronics, semiconductors as used in image sensors and other optical applications.

6. In addition, I am currently the Chairman, CEO, and Director of the Board of Directors for Lightwave Logic. As CEO, I successfully guided Lightwave Logic to up-list to NASDAQ in September 2021 organically (i.e., without the raising of financing), and I led the company to acceptance in the Russell 3000 index in 2022.

7. I have led and run optoelectronics start-ups, and I have commercialized optoelectronic and photonics technologies into volume manufacturing. I have also worked as a Corporate Venture Capitalist specializing in optical communications, photonics, sensing, electronics, and semiconductors, and I am currently a technical expert advising the European Commission regarding evaluation of numerous photonic technology proposals, including image sensor proposals. I am a Fellow Member of the National Academy of Inventors (NAI), the IEEE, and Optica (OSA), and I was voted Photonic Integrated Circuit (PIC) business leader of the year by the PIC International Conference in 2018.

8. In particular, my technical expertise has included the design of components for photonics technology that can source light as well as receive and detect light. These components include LEDs, ICs, lasers, photodetectors, diodes, image sensors, etc. In many of my industrial and commercial roles in the photonics industry I have used, designed, optimized, and improved photonic materials, components, and packages both through solutions of engineering problems as well as patents and publications.

9. Over the course of my career in photonics, optoelectronics, and optical technology in general, I have worked in nearly every aspect of the field, including optical assembly, laser diodes, photodetectors, image sensors, LEDs, integrated circuits (e.g. drivers, and other basic electronic digital and analog functions), as well as fiber optics. In particular, I have designed optoelectronic devices such as LEDs, laser diodes (VCSELs – vertical cavity surface emitting lasers), photodiodes, image sensors, and solar cells with a focus on efficient optical device design that maximizes device performance. For example, I have worked on improving light extraction efficiency in laser diodes as well as LEDs, where these devices are utilized in modules. I have also worked on arrays of detectors for sensing applications.

10. I started my career in 1977 at the Ministry of Defense (United Kingdom), in the Royal Electrical and Mechanical Engineers as a telecommunications apprentice. At the Ministry of Defence, I studied material and characterization issues relating to Gallium Arsenide (GaAs) and Indium Phosphide (InP) optoelectronic devices, as well as semiconductor device design, fabrication, and characterization, particularly with materials using III-V semiconductors. I also worked with silicon for integrated circuits, silicon photonics, and ceramic-based radio-frequency (RF) electronic packaging that included low-temperature co-fired ceramic. These devices and materials were utilized in photonic-based transceiver packages and modules. I also worked on electronics, motors, sensors, and other technologies that combined photonics with electronics.

11. I attended the University of Bradford, where I obtained a Bachelor's of Engineering (Electrical Engineering), with honors, in 1984, an MBA in 1985 and a Ph.D. (Electrical Engineering) in 1987. My Ph.D. thesis related to the characterization and fabrication of both optoelectronic and electronic semiconductor devices that included the detection of light. In 2004, I was awarded a Doctor of Engineering (a Doctorate degree higher than a Ph.D.) from the University of Bradford for my "Technical Contributions to Optoelectronics." This was only the second time in the University of Bradford's history that a Doctor of Engineering was granted based on industry experience.

12. While attending the University of Bradford and for a few years thereafter, i.e., from 1985 to 1989, I worked as a researcher in the Photonics Research Department of AT&T Bell Labs ("Bell Labs"). At Bell Labs, I focused my research on novel device designs using III-V semiconductor material systems including FETs, bipolar transistors, LEDs, laser diodes, and photodetectors. My research at Bell Labs became the subject of my Ph.D. thesis.

13. After completing my Ph.D. at the University of Bradford and my work at Bell Labs, I became a Research and Development Manager ("R&D Manager") in the photonics division of Motorola's Corporate R&D Labs ("Motorola"). I worked at Motorola from 1989 to 1998, where my responsibilities included research and development in optical interconnects, electrical and fiber optic connectors,

optical/electrical engines, electronic ICs, displays, laser devices, LEDs, optical lenses, image sensors, and optical waveguides, as well as the packaging and reliability of mobile product prototypes. Some of the prototypes on which I worked included moving parts with motors (both standard as well as semiconductor MEMs based), and phased array optical beams that could direct and re-direct optical beams. While at Motorola, I was the inventor or co-inventor on over 150 utility patents, and I received a special award from the Chairman of Motorola in 1998 for exemplary patent accomplishments. At that time, I had the highest number of issued utility patents in the history of Motorola.

14. As an R&D Manager at Motorola, I initiated Motorola's work in optical interconnect technology (known at Motorola as "Optobus"TM) and associated optical connectors, electronics, and photonics components, and I was also involved in research and development on the IC chip designs that this parallel interconnect module utilized. In this project, transparent plastics were developed and molded onto standard metallic lead frames for both light-emitting devices (e.g., LEDs, VCSELs) and photodetectors, which collect light and convert it into an electronic signal. These transparent lead frame packages were developed in volume production at Motorola. I also worked on various techniques to improve both photonics based detectors such as photodetectors, image sensors as well as photonics based emitters such as lasers and LEDs, both as individual components as well as in arrays of multiple components.

15. In 1998, I left Motorola to join TE Connectivity (previously Tyco Electronics) as Director of Technology and Business Development. In that role, I helped develop technology strategy for optical communications, optoelectronic transceivers, and fiber optic connector and adapter products for the Global Optoelectronics Division. My work included designing and characterizing photodetectors, sensors, LEDs, laser-based photonic packages and modules for product manufacturing.

16. In 1999, I joined Intel Capital (“Intel”) as Director of Business Development and as a corporate investor. My work at Intel included sourcing, negotiating, and closing private placement equity deals in the optical networking, photonic component, interconnect, optical lens, image sensor, and semiconductor industries. My work at Intel also included investigating the investment of Intel Capital equity in photonic devices, optical beams, and other technologies to support the physical movement of optical signals. I also was one of the founders of Intel’s silicon photonics division, which worked to establish a fabrication facility in South San Jose to investigate silicon based image sensors and the integration of silicon FET electronics with optoelectronics into the same silicon semiconductor wafer.

17. From 2005 to 2010, I served as the Executive Director, President, and CEO of the Optoelectronic Industry Development Association (OIDA) – a trade association that represented photonics manufacturers in the fields of photonic sensing,

fiber optics, display, defense, aerospace, LED lighting and automotive/motor vehicles.

I was responsible for organizing technical conferences, workshops and forecasts using industry roadmaps, all of which featured a portfolio of photonics technology that included: optical sensors, free-space optics, optical interconnects, fiber optics, optical communications, automotive photonic technologies, wavelength division multiplexing, LEDs, displays and their associated packaging.

18. In 2010, I became the General Manager and CTO of Translucent, Inc., a start-up company that developed and manufactured silicon and rare earth oxide-based epitaxial semiconductor wafers.

19. I was employed by Glyndŵr University from 2013 to 2015 as a Professor of Optoelectronics, where I focused on the design, simulation, and testing of high-speed, low-power photonic integrated circuits, optoelectronic integrated circuits, laser diodes, optics, and solar cells for applications that included communications, automotive, displays, sensing, and energy.

20. From 2013 to 2015, I was also employed as the President and CEO of OneChip Photonics Corporation, where I additionally served as an elected independent board member. In these roles, I focused on technical, business, and operational strategy for fiber optic communications based on InP photonic integrated circuits, as well as optoelectronic integrated circuits for fiber optic transceivers that incorporated electrical and optical multiplexing schemes using fiber optic connectors.

21. Over the course of my career, I have also led panels and given numerous keynote and invited presentations, speeches, and talks at workshops and conferences, including on photonic and optoelectronic materials, devices, components, packages as well as photonics technology in general.

22. Due to my passion for optics, I have been elected to the London Guild of Spectacle Makers. A more detailed description of my education, as well as my training and experience in the relevant technology, is included in my CV.

23. I hold over 340 combined issued USPTO patents and USPTO published patent applications that have been derived from over 230 issued U.S. utility patents, mostly in the field of optoelectronics, photonics, electronics, and semiconductors. I have been cited by the USPTO to be in the most prolific seventy-five inventors in the United States from 1988 to 1997.

24. I have authored approximately sixty-five (65) publications, and have achieved over 400 media events that include: technical articles, books, chapters, invited speaker events at conferences as well as for interviews that included TV, video, radio, and social, industrial, professional media in general. This includes technical, business-related, and financial conferences as a contributed, invited, and keynote speaker. Details can be found in my CV. Over the past decade, I have been a project reviewer and technical expert for the European Commission on numerous occasions.

25. I have also served as an expert witness on numerous patent matters, including 50 IPR proceedings and 5 PGR proceedings. I have also served on over 60 oral depositions that include ITC and District court proceedings.

26. A complete listing of these patents, publications, articles, lectures, and other public media is included with my CV.

27. On the basis of my education and the experience described above, I believe I am qualified to give the opinions set out herein.

III. MATERIALS REVIEWED

28. I am not an attorney and offer no legal opinions, but in my work, I have had experience studying and analyzing patents and patent claims from the perspective of a person skilled in the art. *See* Section VI.C below for the level of ordinary skill in the art for this declaration.

29. In preparing this declaration, I reviewed the '737 patent, including the claims of the patent in view of the specification, and I have reviewed the prosecution history of the '737 patent and numerous publications and technical references from and preceding the time of the alleged invention. More specifically, I have reviewed each of the following:

Exhibit	Description
1001	U.S. Patent No. 11,069,737 (the "'737 patent")
1002	File History for U.S. Patent No. 11,069,737
1003	Provisional Application No. 61/841,326
1006	U.S. Patent Application Publication No. 2012/0068289 (Alie)

Exhibit	Description
1007	U.S. Patent Application Publication No. 2006/0081900 (Baggenstoss)
1008	International Publication No. WO 2012/122572 (Jiang)
1009	U.S. Patent Application Publication No. 2012/0313204 (Haddad204)
1010	U.S. Patent Application Publication No. 2010/0006969 (Park)
1011	U.S. Patent No. 7,928,389 (Yap)
1012	U.S. Patent Application Publication No. 2011/0227138 (Haddad138)
1013	Samsung's Proposed Constructions, Inv. No. 337-TA-1403 (Aug. 27, 2024)
1014	SiOnyx's Proposed Constructions, Inv. No. 337-TA-1403 (Aug. 27, 2024)
1015	Email from N. Subhedar re: Claim Construction M&C Follow-Up (Sept. 8, 2024)
1016	U.S. Patent No. 8,680,591 (Haddad138 Issued Patent)
1017	U.S. Patent No. 9,496,308 (Haddad204 Issued Patent)
1018	The Authoritative Dictionary of IEEE Standard Terms (7th ed. 2000)
1019	Stephen Y. Chou et al., <i>Nanoimprint Lithography</i> , J. Vac. Sci. Technol. B 14(6), 4129-33 (1996)
1020	Gary S. May & Simon M. Sze, <i>Fundamentals of Semiconductor Fabrication</i> (2003)
1021	Provisional Application No. 61/311,004 (Haddad138-Provisional004)
1022	Provisional Application No. 61/243,434 (Haddad138-Provisional434)
1023	Provisional Application No. 61/311,107 (Haddad138-Provisional107)
1024	U.S. Patent Application Publication No. 2012/0146172 (Carey)
1025	U.S. Patent No. 7,442,629 (Mazur)
1026	U. Gösele & Q.-Y. Tong, <i>Semiconductor Wafer Bonding</i> (1998)
1027	U.S. Patent Application Publication No. 2011/0304003 (Tanida)
1028	S. Wolf, <i>Microchip Manufacturing</i> (2004)
1029	<i>Encyclopedia of Physical Science and Technology</i> (3rd ed. 2002)
1030	Christoph Posch, <i>Detectors, Pixels, and Signal Processing, in SMART CAMERAS</i> (Ahmed Nabil Belbachir ed., 2010)

IV. RELEVANT LEGAL STANDARDS

30. I am not an attorney. For the purposes of this declaration, I have been informed about certain aspects of the law that are relevant to forming my opinions. I have applied the following understanding of the law.

31. I have been informed that a patent claim may be “anticipated” if each element of that claim is present either explicitly or inherently in a single prior art reference, and that the elements should be arranged in the reference as in the claim. Petitioner’s counsel has informed me that for a claimed limitation to be inherently present, the prior art need not expressly disclose the limitation, so long as the claimed limitation necessarily flows from a disclosure in the prior art.

32. I have been informed that a patent claim can be considered to have been obvious to a person of ordinary skill in the art at the time the application was filed. This means that, even if all of the requirements of a claim are not found in a single prior art reference, the claim is not patentable if the differences between the subject matter in the prior art and the subject matter in the claim would have been obvious to a person of ordinary skill in the art at the time the application was filed.

33. I have been informed that a determination of whether a claim would have been obvious should be based upon several factors, including, among others:

- the level of ordinary skill in the art at the time the application was filed;
- the scope and content of the prior art; and

- what differences, if any, existed between the claimed invention and the prior art.

34. I have been informed that a single reference can render a patent claim obvious if any differences between that reference and the claims would have been obvious to a person of ordinary skill in the art. Alternatively, the teachings of two or more references may be combined in the same way as disclosed in the claims, if such a combination would have been obvious to one having ordinary skill in the art. In determining whether a combination based on either a single reference or multiple references would have been obvious, it is appropriate to consider, among other factors:

- whether the teachings of the prior art references disclose known concepts combined in familiar ways, and when combined, would yield predictable results;
- whether a person of ordinary skill in the art could implement a predictable variation, and would see the benefit of doing so;
- whether the claimed elements represent one of a limited number of known design choices, and would have a reasonable expectation of success by those skilled in the art;
- whether a person of ordinary skill would have recognized a reason to combine known elements in the manner described in the claim;

- whether there is some teaching or suggestion in the prior art to make the modification or combination of elements claimed in the patent; and
- whether the innovation applies a known technique that had been used to improve a similar device or method in a similar way.

35. Petitioner's counsel has informed me that one of ordinary skill in the art has ordinary creativity and is not an automaton. Petitioner's counsel has informed me that in considering obviousness, it is important not to determine obviousness using the benefit of hindsight derived from the patent being considered.

36. I understand that various objective or "real world" factors may be indicative of non-obviousness. I understand that such factors include:

- the commercial success of the claimed invention;
- the existence of a long-felt, unresolved need for a solution to the problem solved by the claimed invention;
- failed attempts to solve the problem solved by the claimed invention;
- copying of the claimed invention;
- unexpected results of the claimed invention;
- praise for the claimed invention by others in the relevant field; and
- willingness of others to accept a license under the patent because of the merits of the claimed invention.

V. TECHNOLOGY BACKGROUND

37. Since the early 2000s, digital cameras and camcorders have become increasingly popular, largely due to the development of advanced image sensors. These sensors play a critical role in converting visual information into electrical signals, which are then processed to create digital images or videos. At the heart of an image sensor lies an array of light-sensitive pixels, each of which is a photodiode capable of detecting light. The photodiode's function is to convert incoming light photons into electrons; the quantity of electrons collected at each pixel determines the pixel's brightness. By assembling this data across all pixels, the sensor constructs a coherent image or video corresponding to the captured scene.

38. In an ideal scenario, an image sensor would achieve perfect efficiency, converting every photon that strikes it into a collected electron. However, in practice, some photons are lost during the conversion process. The efficiency of this conversion is quantified by a metric known as external quantum efficiency, or quantum efficiency for short. Quantum efficiency is defined as the percentage of photons incident on an image sensor that are converted into collected electrons. Ex-1030, 60. Some incident photons may be lost because they are reflected off before reaching the semiconductor layer including a photodiode; others may be lost because they pass through the semiconductor layer without being absorbed. To mitigate such losses, it is common practice to include in an image sensor microstructures that let more light into the

semiconductor layer including a photodiode, as well as microstructures that reflect and scatter light that leaves the semiconductor layer back into the semiconductor layer.

39. Photodiodes are typically fabricated by doping a semiconductor layer to create a junction, which is used for sensing light. A photodiode junction is then connected to a neighboring metallization layer, which carries the electrical signal to external circuits that integrate the signals from all pixels to form a complete image. In the design of image sensors, the side of the semiconductor layer where the photodiode junction and the metallization layer are located is referred to as the “front side,” while the opposite side is known as the “backside.” Image sensors can be designed to receive light from either the front side (front side illuminated, or FSI) or the backside (backside illuminated, or BSI), each offering different advantages and trade-offs.

40. Front side illuminated sensors are easier and less costly to manufacture, but they suffer from greater light loss because the incident light must pass through the metallization layer before reaching the photodiode junction. This can reduce the sensor’s overall efficiency and image quality, especially in low-light conditions. Conversely, backside illuminated sensors are more challenging and expensive to produce but offer superior performance because the incident light directly reaches the photodiode junction without passing through the metallization layer. This design reduces light loss and improves the sensor’s quantum efficiency, leading to better image quality, particularly in demanding lighting environments.

VI. OVERVIEW OF U.S. PATENT NO. 11,069,737

A. Summary

41. The '737 patent relates to photosensitive imager devices. '737 patent, Abstract. The patent admits that silicon imaging devices were widely used and that they were used in both front side illumination (FSI) and backside illumination (BSI) configurations. '737 patent, 1:18-30. In an FSI device, light enters from the side containing circuitry for the device's photodiode. '737 patent, 5:57-59. In a BSI device, light enters from the opposite side. '737 patent, 6:1-3. The patent alleges that traditional photosensitive imager devices were inefficient at detecting infrared light. '737 patent, 1:33-36.

42. The '737 patent purports to improve upon traditional photosensitive imager devices by adding a textured layer. Figure 2 depicts an embodiment:

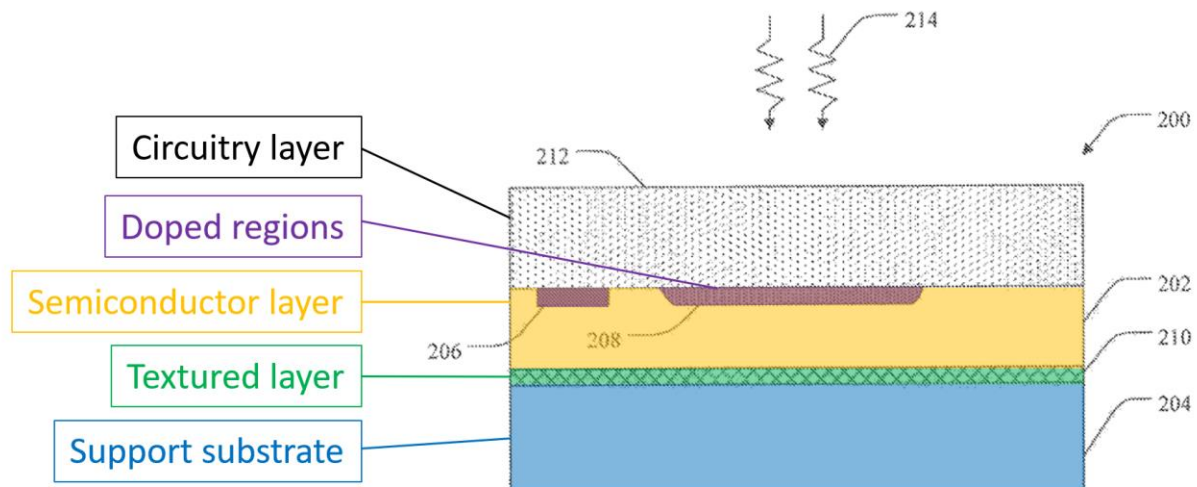


FIG. 2

'737 patent, Fig. 2 (annotated).

43. Light 214 is incident on a circuitry layer 212 and travels to a semiconductor layer 202. '737 patent, 6:41-44. The semiconductor layer 202 has doped regions 206 and 208 that form a junction for sensing light. '737 patent, 6:33-37. On the bottom side of the semiconductor layer (opposite the light incident side) is a textured layer containing surface features. '737 patent, 6:37-39. The textured layer reflects back to the semiconductor layer some of the light that passes through the semiconductor layer, giving the semiconductor layer another chance to absorb the light. '737 patent, 6:44-48. The textured layer allegedly functions to “diffuse light, to redirect light, and to thus increase the quantum efficiency.” '737 patent, 9:21-23. Although the textured layer in Figure 2 is located on the side of the semiconductor layer opposite the light incident side, the textured layer could be located on the light incident side, or both on the light incident side and opposite the light incident side. '737 patent, 7:40-45.

B. Prosecution History

44. The '737 patent was filed on July 8, 2019, claiming priority to Provisional Application No. 61/841,326, filed on June 29, 2013.

45. Following an office rejection, the applicant added the following limitation to claim 21 (issued claim 1): “wherein the surface features are arranged according to a pattern.” Ex-1002 at 86.

46. The applicant also added the following limitations to claim 47 (issued claim 26):

wherein the surface features are formed via etching;

depositing an oxide material within at least a portion of the semiconductor layer or support substrate removed during etching; and

processing the region of the semiconductor layer or support substrate comprising the surface features with CMP after depositing the oxide material.

Ex-1002 at 88.

47. The applicant also added a new claim 56 (issued as claim 32). Ex-1002 at 89.

48. Following the applicant's amendments, the examiner only rejected claims 80-83. Ex-1002 at 108. After the applicant cancelled those claims, Ex-1002 at 171, the examiner issued a notice of allowance.

C. Level of Ordinary Skill in the Art

49. It is my understanding that factors defining the level of ordinary skill in the art include: (1) the types of problems encountered in the art; (2) the prior art solutions to those problems; (3) the rapidity with which innovations are made; (4) the sophistication of technology; and (5) the educational level of active workers in the field.

50. A person of ordinary skill in the art (“POSITA”) as of June 2013 would have had a Bachelor’s degree in engineering, physics, or a related or equivalent field, and two or more years of experience researching, developing, designing, and/or evaluating image sensors using photonics. A person with less or different education but more relevant practical experience, or vice versa, may also meet this standard.

51. I met this definition of a POSITA as of June 2013. I applied this definition of a POSITA in forming my opinion in this declaration. I understand that SiOnyx, LLC (“SiOnyx” or “Patent Owner”) asserted the ’737 patent in a related case, *Sensors with Pixels and Products Containing the Same*, Inv. No. 337-TA-1403 (the “Related Case”). I understand that Patent Owner’s expert in the Related Case opined that “[t]he level of ordinary skill for the Asserted Patents should be defined as a person having at least a bachelor’s degree in electrical engineering, materials science, or physics, (or an equivalent technical degree), at least two years of experience in optoelectronics, and at least three years of work experience in semiconductor manufacturing. Further, a master’s degree or Ph.D. in a relevant field may substitute for some work experience or vice versa.” I met Patent Owner’s definition of a POSITA as of June 2013. My opinions remain the same under Patent Owner’s definition.

D. Claim Construction

52. I understand that in this proceeding, the claims should be construed in accordance with their ordinary and customary meaning in light of the specification, as

understood by one of ordinary skill in the art. I have therefore applied those plain and ordinary meanings in my analysis.

53. I understand that, in the Related Case, Petitioner and Patent Owner have proposed competing constructions for certain terms of the '737 patent. *See* Ex-1013; Ex-1014; Ex-1015.

54. For purposes of my opinions, I was asked to apply the parties' proposed constructions where both parties' proposed constructions were available and consistent with the plain and ordinary meaning. Where Petitioner proposed a certain term was indefinite, I was asked to apply Patent Owner's proposed construction where it did not conflict with the plain and ordinary meaning.

VII. OVERVIEW OF THE PRIOR ART

A. U.S. Patent Application Publication No. 2011/0227138 (Haddad138) (Ex-1012)

55. I understand that Haddad138 is prior art because it was published on September 22, 2011, which is more than one year before the '737 patent's provisional application filing date of June 29, 2013.

56. Although Haddad138 was listed in an information disclosure statement (IDS) along with over 1,000 other documents, it was not discussed during prosecution.

57. Like the '737 patent, Haddad138 was assigned to SiOnyx. *See* Ex-1016. The named inventors of the '737 patent, Homayoon Haddad and Jutao Jiang, are also

joint inventors of Haddad138. The '737 patent's provisional application refers to Haddad138 for "[f]urther details regarding both BSI and FSI photodiodes, pixels, imagers, and other optoelectronic devices," incorporating the patent application for Haddad138 by reference. Ex-1003, 9:18-20. Like the '737 patent, Haddad138 discloses a photodetector with a textured region. Haddad138, [0087], [0064]. Figure 9 depicts an embodiment.

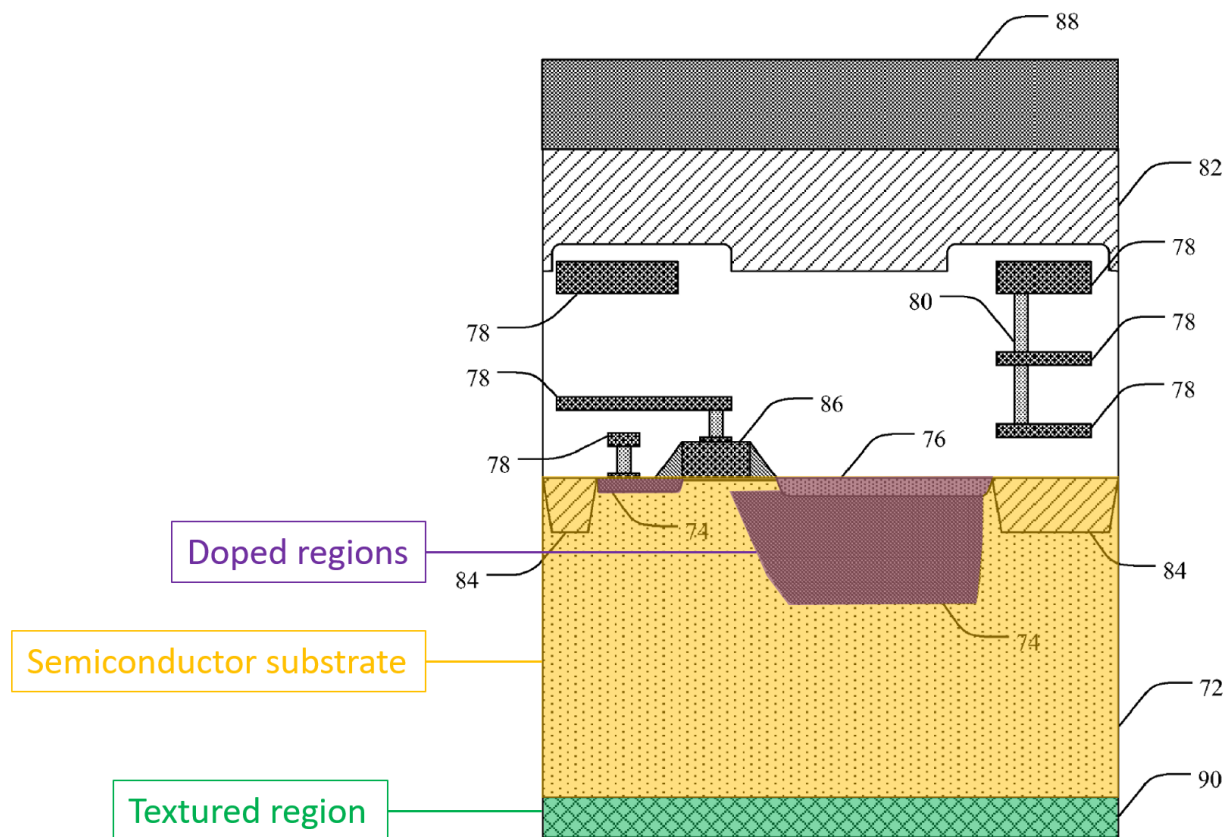


FIG. 9

Haddad138, Fig. 9 (annotated).

58. Haddad138 discloses that its “textured region can function to diffuse electromagnetic radiation, to redirect electromagnetic radiation, and to absorb

electromagnetic radiation, thus increasing the quantum efficiency of the device.”

Haddad138, [0063].

59. Like the ’737 patent, Haddad138 discloses that its devices “can be front side illumination (FSI) or back side illumination (BSI) devices” and “can be adapted for either configuration.” Haddad138, [0048].

**B. U.S. Patent Application Publication No. 2006/0081900
(Baggenstoss) (Ex-1007)**

60. I understand that Baggenstoss is prior art because it was published on April 20, 2006, which is more than one year before the ’737 patent’s provisional application filing date of June 29, 2013.

61. Baggenstoss was not listed in an IDS and it was not discussed during prosecution. A parent application (of which Baggenstoss is a divisional) was listed in an IDS along with over 1,000 other documents, but it was not discussed during prosecution.

62. Baggenstoss discloses a photodetector with a grated interface formed by trenches 144. Baggenstoss, [0031]-[0032], [0009].

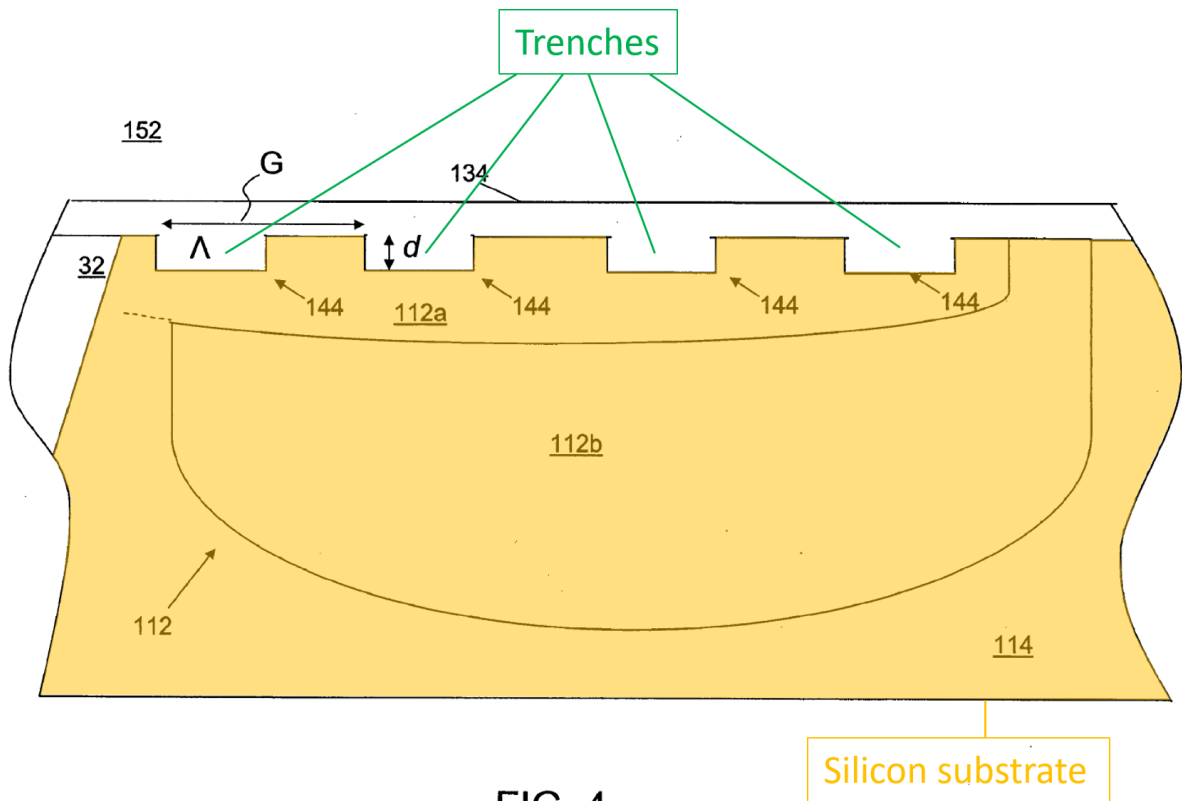


FIG. 4

Baggenstoss, Fig. 4 (annotated).

63. In another embodiment, Baggenstoss discloses a pixel cell with a “blazed (or step-wise)” gratings formed of trenches 244. Baggenstoss, [0042].

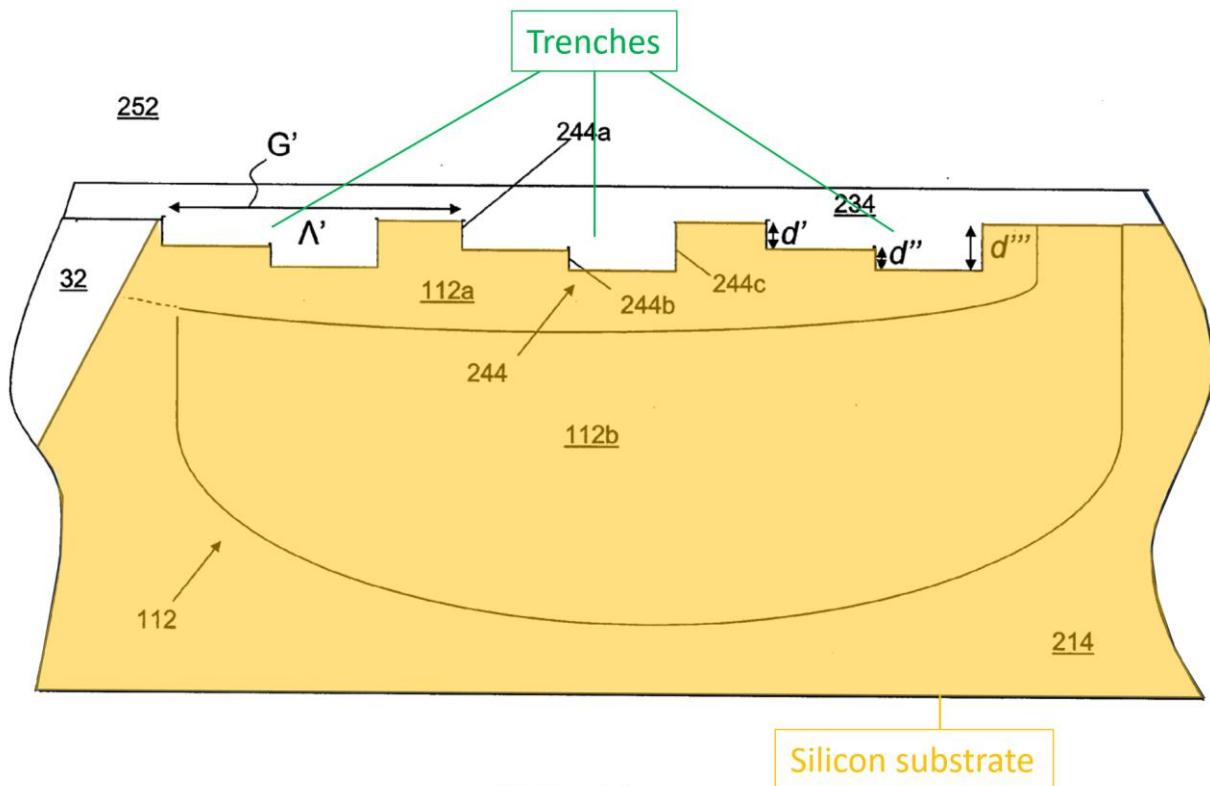


FIG. 11

Baggenstoss, Fig. 11 (annotated).

64. Baggenstoss teaches that its “grated interface allows a greater percentage of incident light to be captured, which is a vast improvement over the art.” Baggenstoss, [0014].

C. International Publication No. WO 2012/122572 (Jiang) (Ex-1008)

65. I understand that Jiang is prior art to all claims of the '737 patent because it was published on September 13, 2012, which is before the '737 patent's provisional application filing date of June 29, 2013.

66. I understand that Jiang is prior art to claims 16 and 32-55 of the '737 patent also because it was published on September 13, 2012, which is more than one

year before the earliest non-provisional application filing date of November 19, 2013 for the '737 patent family. Although the '737 patent's provisional application was filed on June 29, 2013, it did not support claims 16 and 32-55 because it lacked any disclosure of the device exhibiting a quantum efficiency of at least about 35% for electromagnetic radiation at a wavelength of about 940 nm, as required by these claims. Ex-1003.

67. Jiang was not listed in an IDS and it was not discussed during prosecution.

68. Like the '737 patent, Jiang was assigned to SiOnyx. The named inventors of the '737 patent, Homayoon Haddad and Jutao Jiang, are also joint inventors of Jiang. Like the '737 patent and Haddad138, Jiang discloses a photodetector with a textured region. Jiang, Abstract, 11:1-4. Indeed, Jiang incorporates the patent application for Haddad138 by reference in its entirety, noting that Haddad138's devices have the same "light absorbing properties and elements" as those of Jiang's devices. Jiang, 13:32-14:2.

69. Figure 15 of Jiang discloses that the quantum efficiency of an example device with a textured region is well over the claimed 35%, at around 70% for electromagnetic radiation at a wavelength of about 940 nm. Jiang, 1:32-35, 16:19-23.

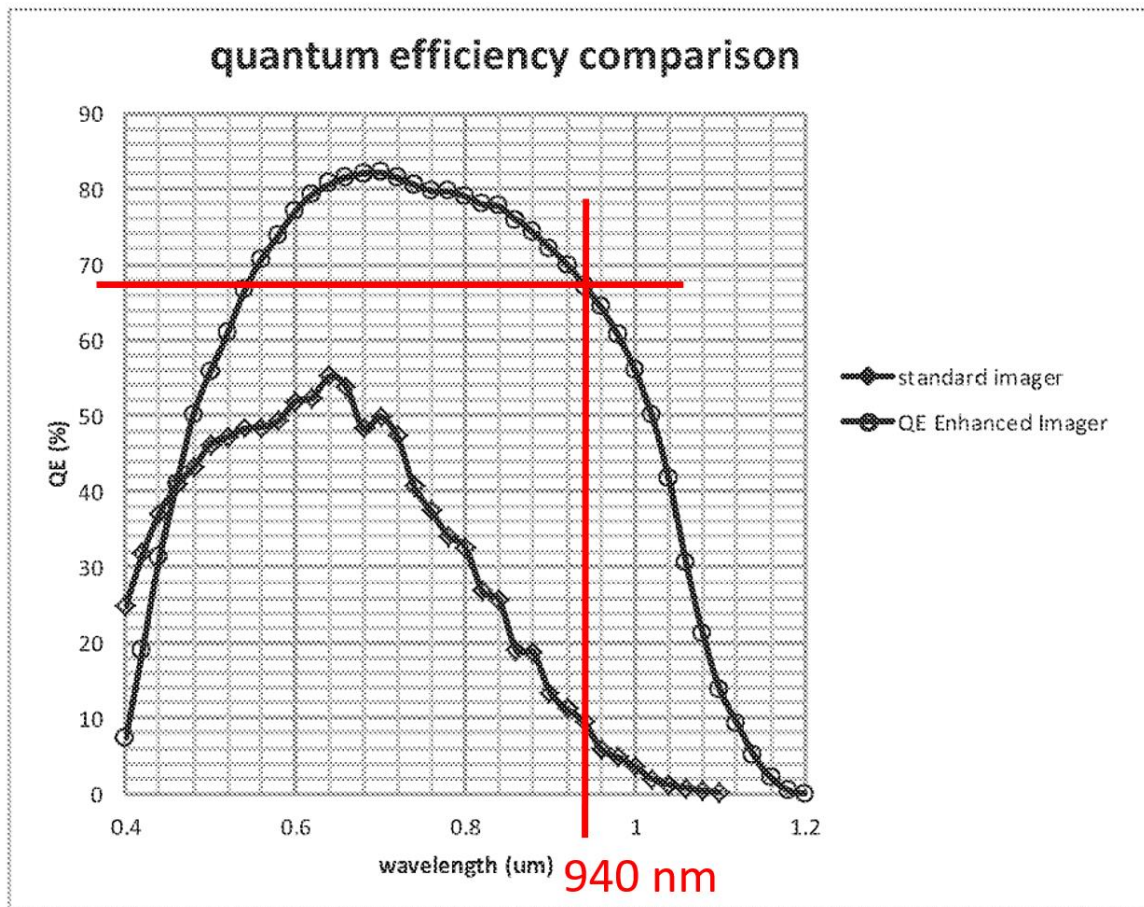


FIG. 15

Jiang, Fig. 15 (annotated).

D. U.S. Patent Application Publication No. 2012/0068289 (Alie) (Ex-1006)

70. I understand that Alie is prior art because it was published on March 22, 2012, which is more than one year before the '737 patent's provisional application filing date of June 29, 2013.

71. Alie was not listed in an IDS and it was not discussed during prosecution.

72. Like the '737 patent, Alie was assigned to SiOnyx. The '737 patent refers to Alie for “[f]urther details regarding substrates, bonding, and various imager details,” incorporating Alie’s patent application by reference. '737 patent, 7:18-21. Like the '737 patent, Alie discloses a photodetector with a textured region. Alie, [0096], [0006].

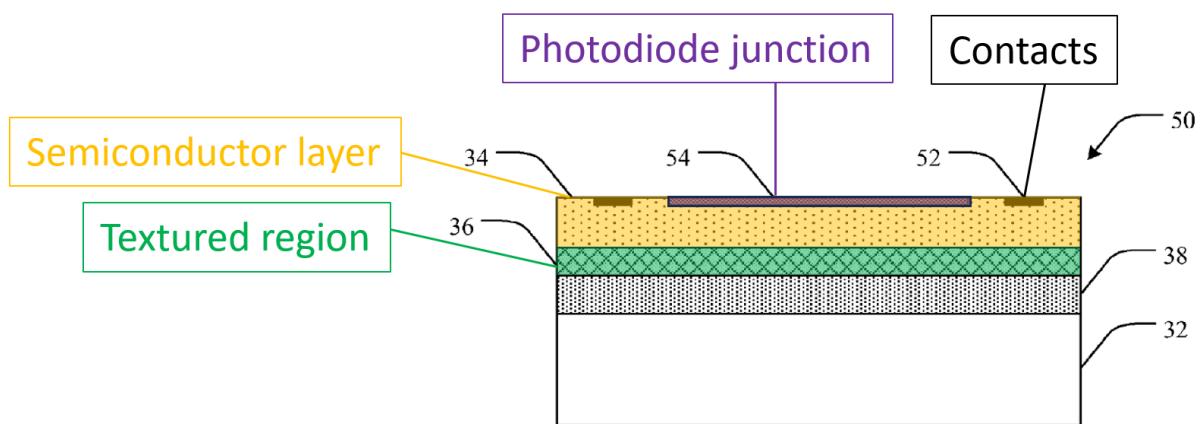


FIG. 5

Alie, Fig. 5 (annotated).

73. Alie discloses that “[t]he textured region can function to diffuse electromagnetic radiation, to redirect electromagnetic radiation, and/or to absorb electromagnetic radiation, thus increasing the quantum efficiency of the device.” Alie, [0068].

74. Like the '737 patent, Alie discloses that its devices can be front side illumination (FSI) or back side illumination (BSI) devices. Alie, [0053].

**E. U.S. Patent Application Publication No. 2012/0313204
(Haddad204) (Ex-1009)**

75. I understand that Haddad204 is prior art because it was published on December 13, 2012, which is before the '737 patent's provisional application filing date of June 29, 2013.

76. Although Haddad204 was listed in an IDS along with over 1,000 other documents, it was not discussed during prosecution.

77. Like the '737 patent, Haddad204 was assigned to SiOnyx. *See* Ex-1017. The named inventors of the '737 patent, Homayoon Haddad and Jutao Jiang, are also joint inventors of Haddad204. Like the '737 patent, Haddad204 discloses a photodetector with a textured region including surface features. Haddad204, [0073], [0053]. In particular, Haddad204 discloses “a plurality of pillars of variable sizes ... arranged in a non-uniform array.” Haddad204, [0112]. Figure 9a shows a top view and Figure 9b shows a cross-sectional view of such “pillars etched into a semiconductor material.” Haddad204, [0112].

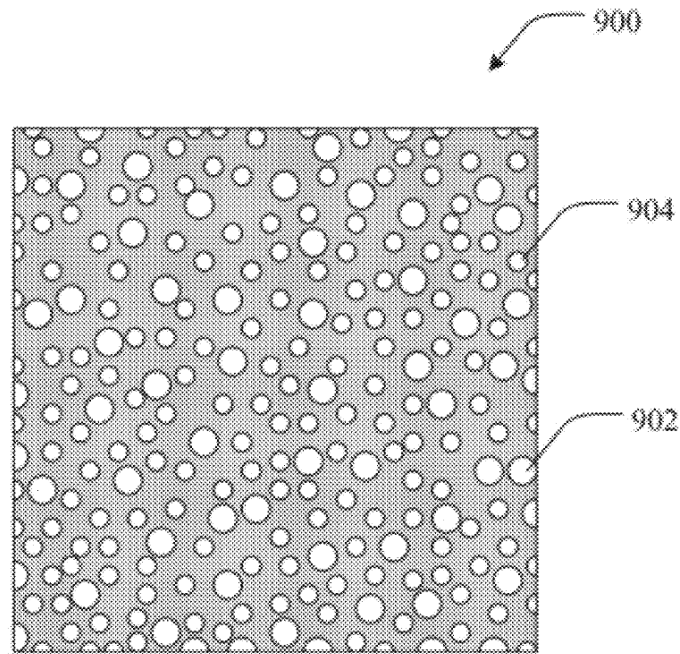


FIG. 9a

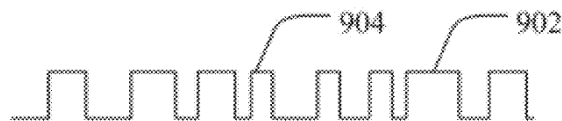


FIG. 9b

Haddad204, Figs. 9a-b.

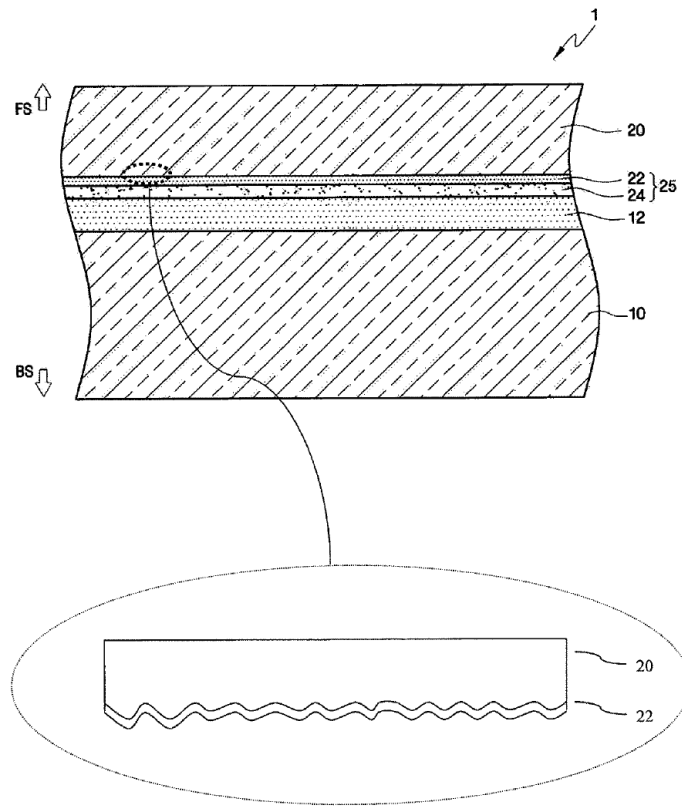
F. U.S. Patent Application Publication No. 2010/0006969 (Park) (Ex-1010)

78. I understand that Park is prior art because it was published on January 14, 2010, which is more than one year before the '737 patent's provisional application filing date of June 29, 2013.

79. Park was not listed in an IDS and it was not discussed during prosecution.

80. Like the '737 patent, Park discloses a photodetector with a textured region including surface features. Park, [0072] (“Referring to the inset in FIG. 1 ... reflections may also be reduced by processing the second substrate 20 to have an uneven surface facing the oxide layer 22.”), Fig. 8D-2(f).

FIG. 1



Park, Fig. 1.

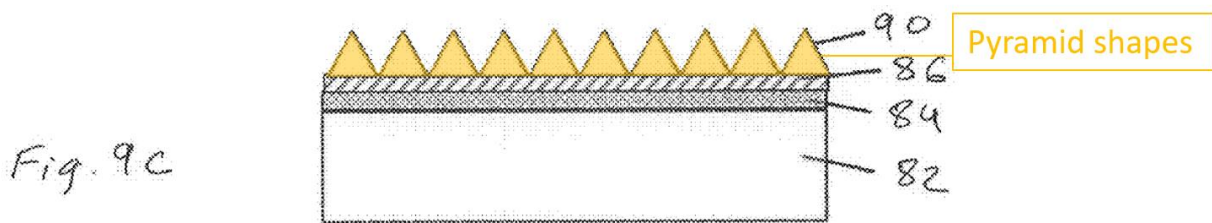
81. Park teaches that the uneven surface helps with absorbing incident light by reducing reflection. Park, [0072].

G. U.S. Patent No. 7,928,389 (Yap) (Ex-1011)

82. I understand that Yap is prior art because it was issued on April 19, 2011, which is more than one year before the '737 patent's provisional application filing date of June 29, 2013.

83. Yap was not listed in an IDS and it was not discussed during prosecution.

84. Like the '737 patent, Yap discloses a method of making a photodetector with a pyramidal shaped semiconductor surface. Yap, Abstract, 8:25-27, Fig. 11. Specifically, Yap discloses etching an n-doped absorber layer 88 into pyramid shapes 90. Yap, 8:25-27.



Yap, Fig. 9c (annotated).

85. Yap discloses that “[t]he set of pyramids act to reduce the reflection of the incident light.” Yap, 7:18-20.

VIII. CLAIMS ANALYSIS

A. Ground A-1: Claims 1-11, 13-16, 18-19, 22, 25, 32-42, 44-46, 48-49, 52, and 55 Are Anticipated, or at a Minimum Obvious, Based on Haddad138

1. Claim 1

a) 1[pre]: “A photosensitive imager device capable of detecting visible and infrared electromagnetic radiation, comprising:”

86. Haddad138 discloses this preamble under both Petitioner’s and Patent Owner’s proposed constructions in the Related Case.

87. In the Related Case, I understand that Petitioner proposed that the preamble is limiting and means, “An image sensor pixel capable of detecting visible and infrared electromagnetic radiation.” Ex-1013, 4. I understand that Patent Owner proposed that the term has a plain and ordinary meaning, and that to the extent a construction is required, it means, “A device with multiple pixels arranged to capture an image from visible and/or infrared light.” Ex-1014, 3-4. Haddad138 discloses “photosensitive diodes, pixels, and imagers capable of detecting visible as well as infrared electromagnetic radiation.” Haddad138, [0045].

b) 1[a]: “a semiconductor layer having a light incident side and an opposed side, said semiconductor layer having multiple doped regions forming at least one junction,”

88. Haddad138 discloses this limitation.

89. Figure 9 depicts a photosensitive pixel device containing a semiconductor substrate 72 (i.e., the claimed semiconductor layer) having multiple doped regions 74 and 76. Haddad138, [0084].

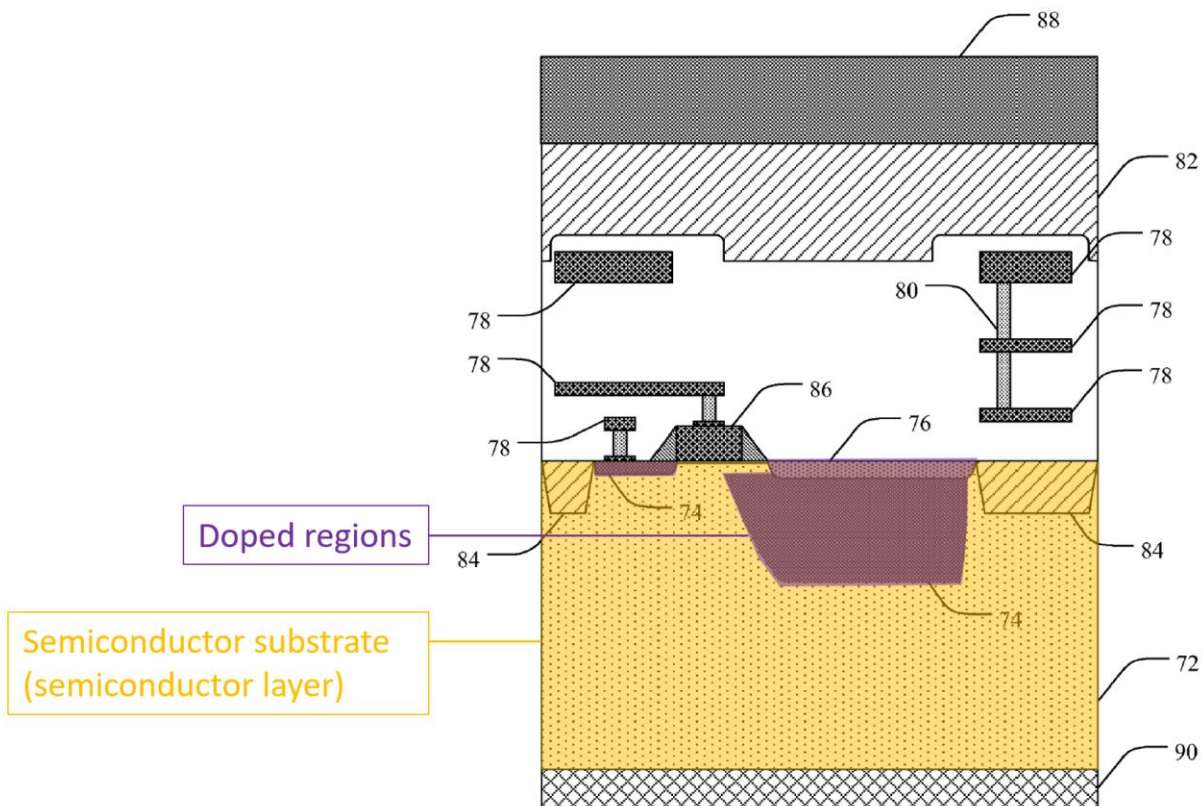


FIG. 9

Haddad138, Fig. 9 (annotated).

90. The doped regions “create a pinned diode,” Haddad138, [0084], which corresponds to the “junction” required by this limitation. Ex-1018, 309 (“diode ... in a more restricted usage, a semiconductor device that has the asymmetrical voltage-current characteristic exemplified by a single p-n junction”); *see also* Haddad138, [0084] (“the semiconductor substrate can be negative in polarity, and the doped region

and the highly doped region can be doped with p⁺ and n⁻ dopants respectively”); Ex-1018, 598 (“junction ... A region of transition between semiconductor regions of different electrical properties (for example, n-n⁺, p-n, p-p⁺ conductors)”); Haddad138, Abstract (“a photosensitive imager device can include a semiconductor substrate having multiple doped regions forming at least one junction”).

91. As depicted in Figure 9, the semiconductor substrate 72 has a top surface and a bottom surface, which correspond to the claimed light incident side and the opposed side. Which surface corresponds to the claimed light incident side depends on whether the Figure 9 device is adapted for a front side illumination configuration or for a back side illumination configuration, as discussed below regarding claim 2.

92. Although Haddad138 states that “FIGS. 7-11 show various steps in the manufacture of a photosensitive pixel according to aspects of the present disclosure,” Haddad138, [0084], Figure 9 is not merely an intermediate manufacturing step, but an embodiment of Haddad138’s invention. The subsequent Figures 10 and 11 disclose optional modifications to the Figure 9 embodiment. Haddad138, [0088] (“As is shown in FIG. 10, an additional carrier support substrate 100 **can** be coupled A reflective layer 102 **can** be disposed”), [0089] (“As is shown in FIG. 11, the carrier support substrate **can** be removed”).¹

¹ All emphases in quotes have been added, unless otherwise stated.

93. Therefore, Haddad138 discloses this limitation.

- c) **1[b]: “a textured region comprising a plurality of surface features configured to interact with incident electromagnetic radiation so as to increase the quantum efficiency of the device, wherein the surface features are arranged according to a pattern,”**

94. Haddad138 discloses this limitation, or at a minimum, renders this limitation obvious under Patent Owner’s proposed construction in the Related Case.

95. In the Related Case, I understand that Petitioner proposed that the term “a textured region comprising a plurality of surface features configured to interact with incident electromagnetic radiation so as to increase the quantum efficiency of the device” means “a region that includes features that diffuse electromagnetic radiation, redirect electromagnetic radiation, and/or absorb electromagnetic radiation, thus increasing the quantum efficiency of the device” and is indefinite. Ex-1015, 1. I understand that Patent Owner proposed that the term means “a region that includes features that diffuse, redirect, absorb, and/or increase the effective absorption length of the device.” Ex-1015, 2.

96. Figure 9 depicts a textured region 90. Haddad138, [0087].

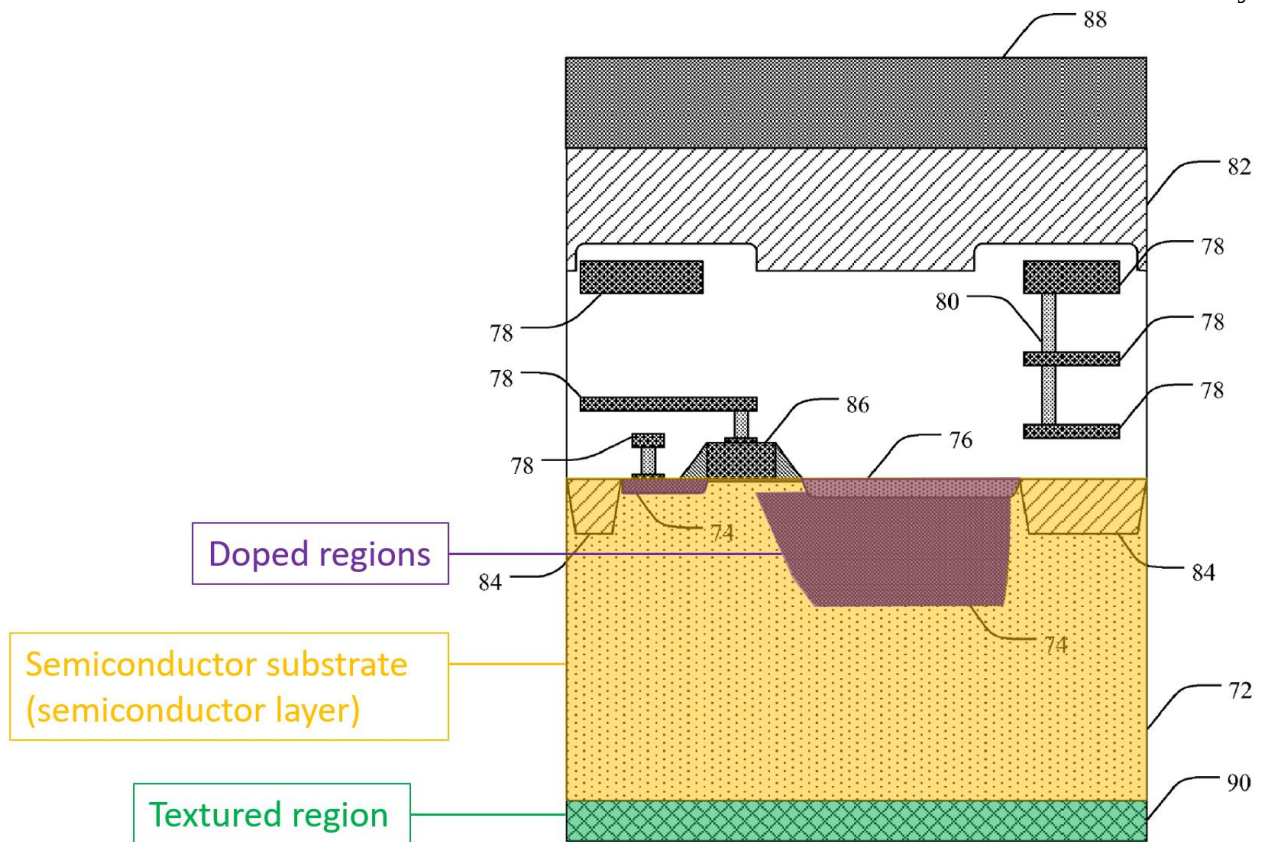


FIG. 9

Haddad138, Fig. 9 (annotated).

97. Haddad138 discloses that its textured region is “positioned to interact with electromagnetic radiation.” Haddad138, [0049]; *see also* Haddad138, [0065] (disclosing a textured region causing “multiple passes of incident electromagnetic radiation,” which “increases the effective absorption length,” which in turn, “increases the quantum efficiency”). Specifically, Haddad138 discloses that the textured region “can function to diffuse electromagnetic radiation, to redirect electromagnetic radiation, and to absorb electromagnetic radiation, thus increasing the quantum efficiency of the device.” Haddad138, [0063]. Haddad138 further discloses that “[t]he

textured region can include surface features to increase the effective absorption length of the photosensitive pixel.” Haddad138, [0063].

98. In the Related Case, I understand that Petitioner proposed that the term “the surface features are arranged according to a pattern” is indefinite. Ex-1013, 4. I understand that Patent Owner proposed that the term has a plain and ordinary meaning and that, to the extent a construction is required, it means “features coincident with at least one surface that are arranged in a repeating manner.” Ex-1014, 4. Haddad138 discloses that the surface features are arranged according to a pattern under Patent Owner’s proposed construction in the Related Case. Haddad138 discloses “surface features appearing as microstructures or ***patterned areas on the surface***.” Haddad138, [0070]. Moreover, Haddad138 discloses forming surface features using nanoimprinting, Haddad138, [0006], which involves using a mold to create imprints on the target material, thus resulting in a formation of features coincident with at least one surface that are arranged in a repeating manner. Ex-1019, 4129. Haddad138 also discloses forming surface features using chemical etching, Haddad138, [0006], which involves the use of a mask that results in the formation of features coincident with at least one surface that are arranged in a repeating manner. *See, e.g.*, Ex-1020, 87; Yap, 8:25-29.

99. Therefore, Haddad138 discloses this limitation, or at a minimum, renders this limitation obvious under Patent Owner's proposed construction in the Related Case.

d) 1[c]: “a support substrate coupled to said semiconductor layer, and”

100. Haddad138 discloses this limitation.

101. Figure 9 depicts a carrier support substrate 88 (i.e., the claimed support substrate) coupled to a semiconductor substrate 72 (i.e., the claimed semiconductor layer). Haddad138, [0086]-[0088].

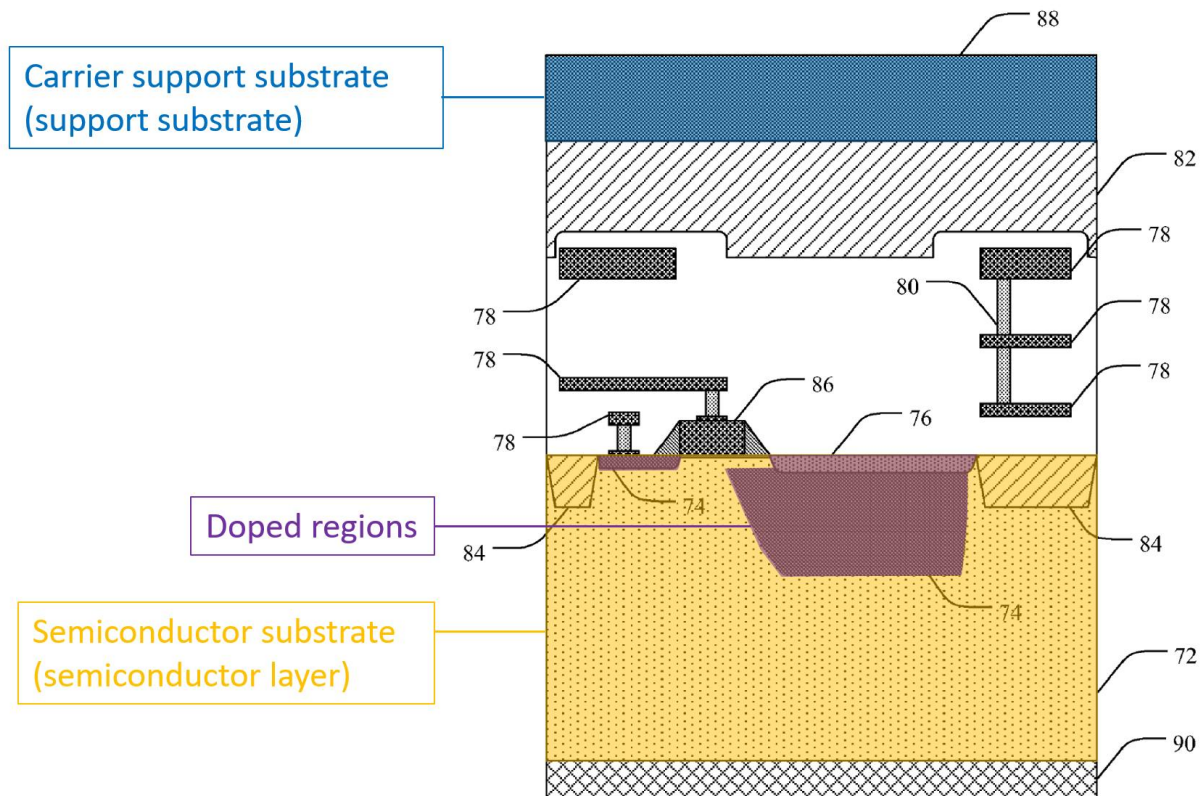


FIG. 9

Haddad138, Fig. 9 (annotated).

e) 1[d]: “a first bonding layer disposed between the semiconductor layer and the support substrate.”

102. Haddad138 discloses this limitation.

103. Haddad138 discloses that “[t]he carrier substrate can be coupled to the photosensing pixel [including the semiconductor layer] by various techniques” including “by way of a bonding layer” (i.e., the claimed first bonding layer). Haddad138, [0086]. One of Haddad138’s provisional applications, to which Haddad138 claims priority and incorporates by reference, illustrates such a bonding layer. Haddad138-Provisional004, 4-5.

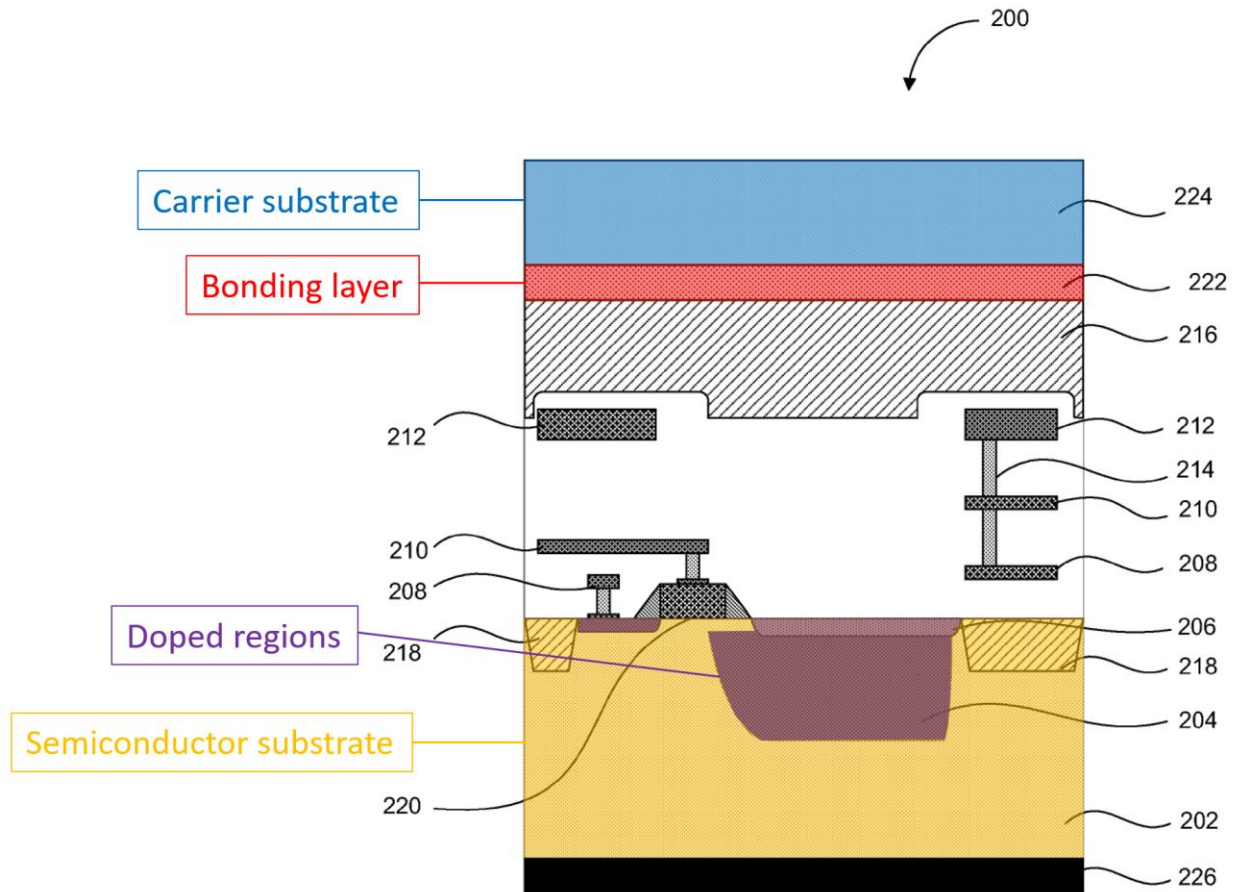


FIG. 4

Haddad138-Provisional004, Fig. 4 (annotated).

2. Claim 2

- a) **“The device of claim 1, wherein the textured region is located on the light incident side of the semiconductor layer.”**

104. Haddad138 discloses this limitation.

105. As discussed above regarding limitation 1[b], Figure 9 depicts a textured region 90 located on the bottom surface of the semiconductor substrate 72.

Haddad138, [0087].

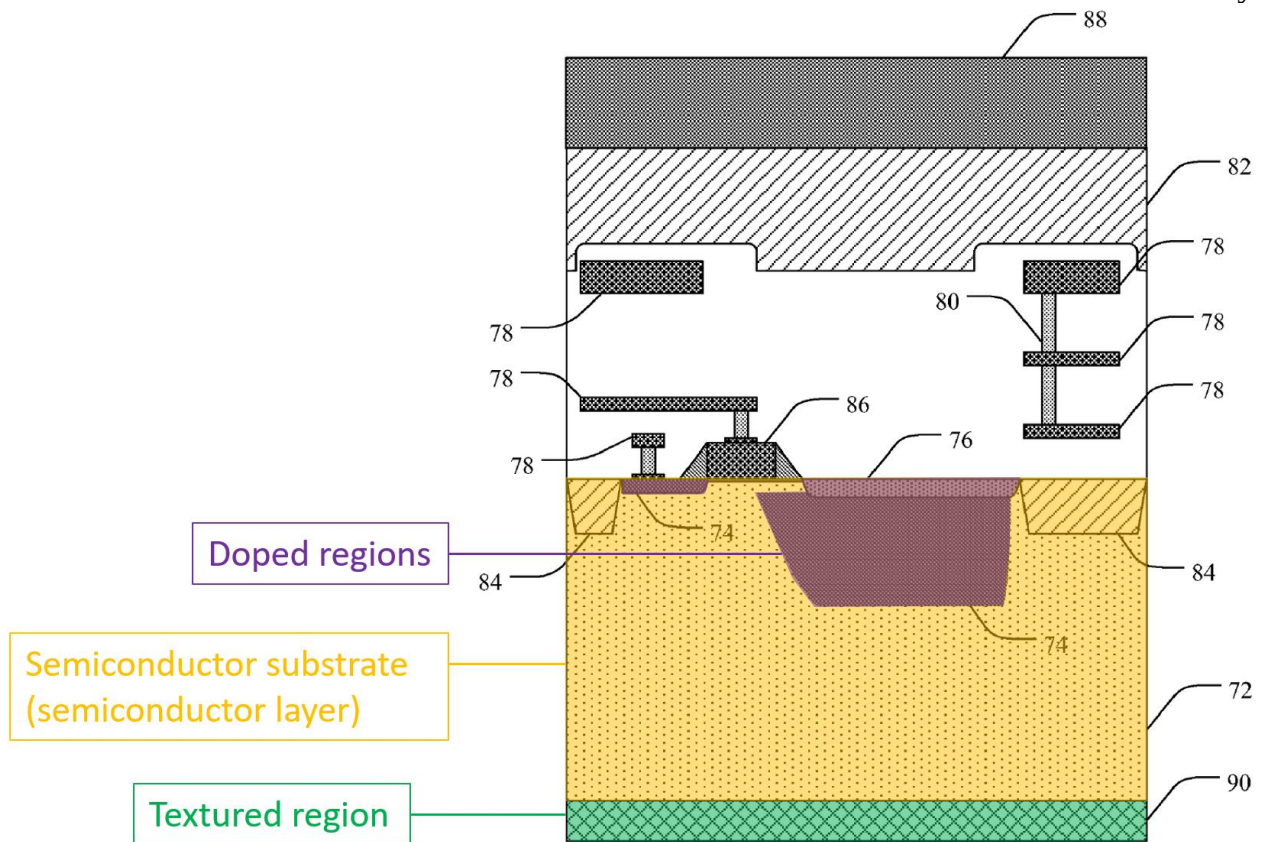


FIG. 9

Haddad138, Fig. 9 (annotated).

106. Haddad138 discloses that its devices “can be front side illumination (FSI) or back side illumination (BSI) devices” and “can be adapted for either configuration.” Haddad138, [0048]. “In a typical FSI imager, incident light enters the semiconductor device by first passing by transistors and metal circuitry.” Haddad138, [0048]. Thus, in an FSI configuration, incident light enters the device from the top, through a layer containing metal regions 78, and through the top surface of the semiconductor substrate 72 containing multiple doped regions 74 and 76. *See* Haddad138, [0048]; *see also*

Haddad138, [0049] (explaining that, in an FSI configuration, “light enters the semiconductor substrate from the direction of the multiple doped regions”).

107. In a BSI configuration, on the other hand, incident light enters the device from the bottom, through the bottom surface of the semiconductor substrate 72. *See* Haddad138, [0048] (disclosing that in BSI imagers “incident light enters the device via the light sensing portion and is mostly absorbed prior to reaching the circuitry”); *see also* Haddad138-Provisional004, 4 (“BSI imagers are configured to have the light sensing portion opposite the transistor and circuitry”); Haddad138, [0049] (“It should also be noted that the photosensitive diode can be configured with a BSI architecture, and thus electromagnetic radiation would enter the semiconductor substrate from the direction of the textured region [that is located on the opposite side of the multiple doped regions].”); Ex-1024, Fig. 6 (depicting an example BSI device where light is incident on the textured region located on the backside of a silicon material 62 opposite the doped regions 64 and 66).

108. In this configuration, the bottom surface of the semiconductor substrate 72 (where the textured region 90 is located) corresponds to the claimed light incident side of the semiconductor layer. One of Haddad138’s provisional applications, to which Haddad138 claims priority and incorporates by reference, explains that a textured region located on the light incident side can “enhance the absorption

properties by reducing the amount of incident electromagnetic radiation that is reflected from the device.” Haddad138-Provisional434, 5.

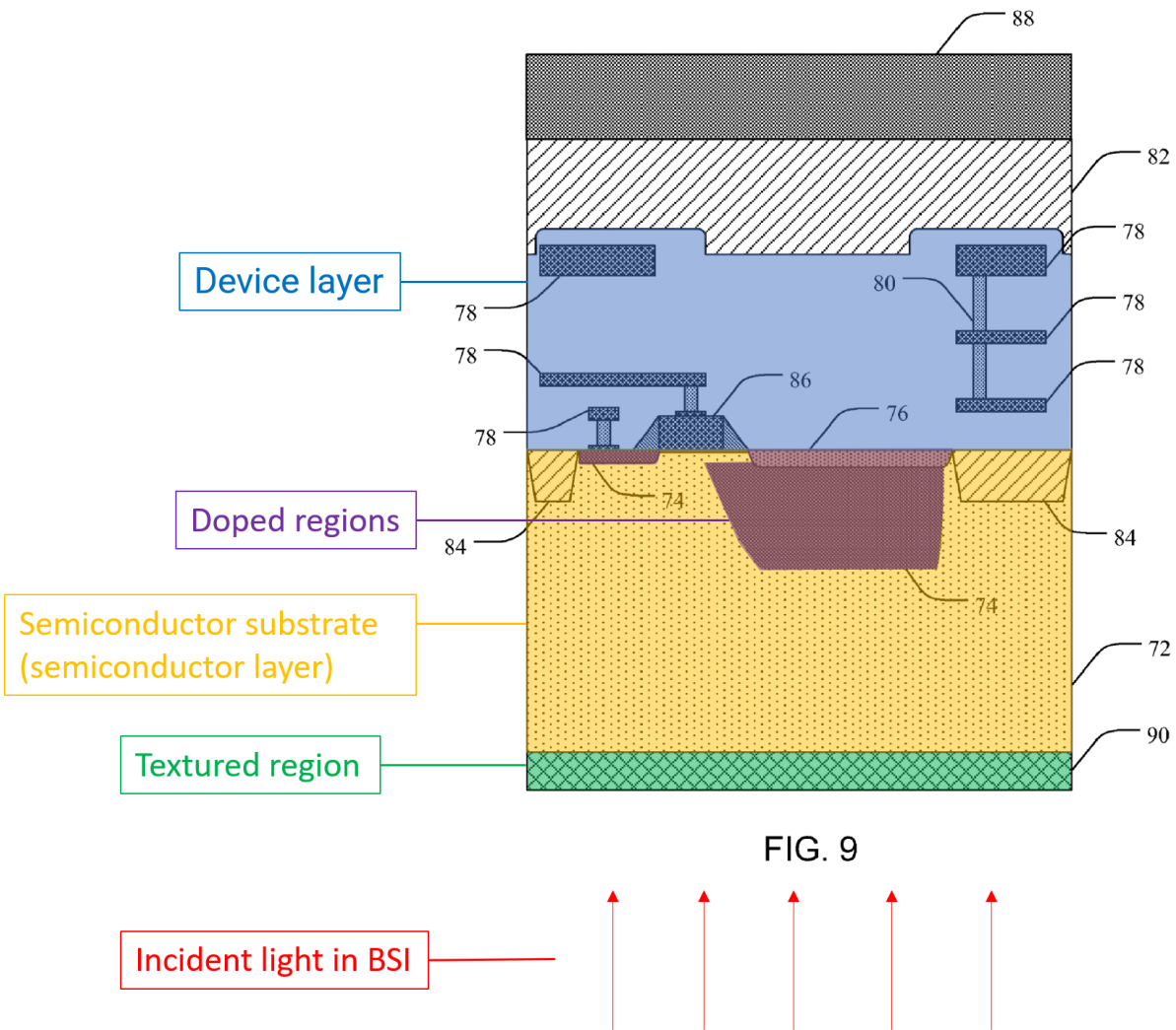
109. Therefore, Haddad138 discloses this limitation.

3. Claim 3

- a) “The device of claim 2, further comprising a device layer coupled to the semiconductor layer on said side opposed to the light incident side.”**

110. Haddad138 discloses this limitation.

111. Figure 9 depicts a layer containing metal regions 78 (i.e., the claimed device layer) coupled to the top surface of the semiconductor substrate 72 (i.e., the claimed semiconductor layer). Haddad138, [0084]-[0085].



Haddad138, Fig. 9 (annotated). The provisional application to the '737 patent refers to such a metallization layer as a device layer. Ex-1003, Fig. 3.

112. As discussed above regarding claim 2, in a BSI configuration, incident light enters the device from the bottom. See Haddad138, [0048]-[0049]. In this configuration, the bottom surface of the semiconductor substrate 72 corresponds to the claimed light incident side of the semiconductor layer and the top surface (to which

Haddad138's device layer is coupled) corresponds to the claimed side opposed to the light incident side.

113. Therefore, Haddad138 discloses this limitation.

4. Claim 4

a) “The device of claim 2, wherein the textured region is formed by etching.”

114. Haddad138 discloses this limitation.

115. Haddad138 discloses that “the textured region can be formed by a variety of processes,” including “chemical etching (e.g. anisotropic etching, isotropic etching).” Haddad138, [0006]; *see also* Haddad138, [0066].

5. Claim 5

a) “The device of claim 4, wherein said surface features comprise pyramids.”

116. Haddad138 discloses this limitation.

117. Haddad138 discloses that “[t]he surface features can be ... pyramids.” Haddad138, [0063]; *see also* Haddad138, [0066].

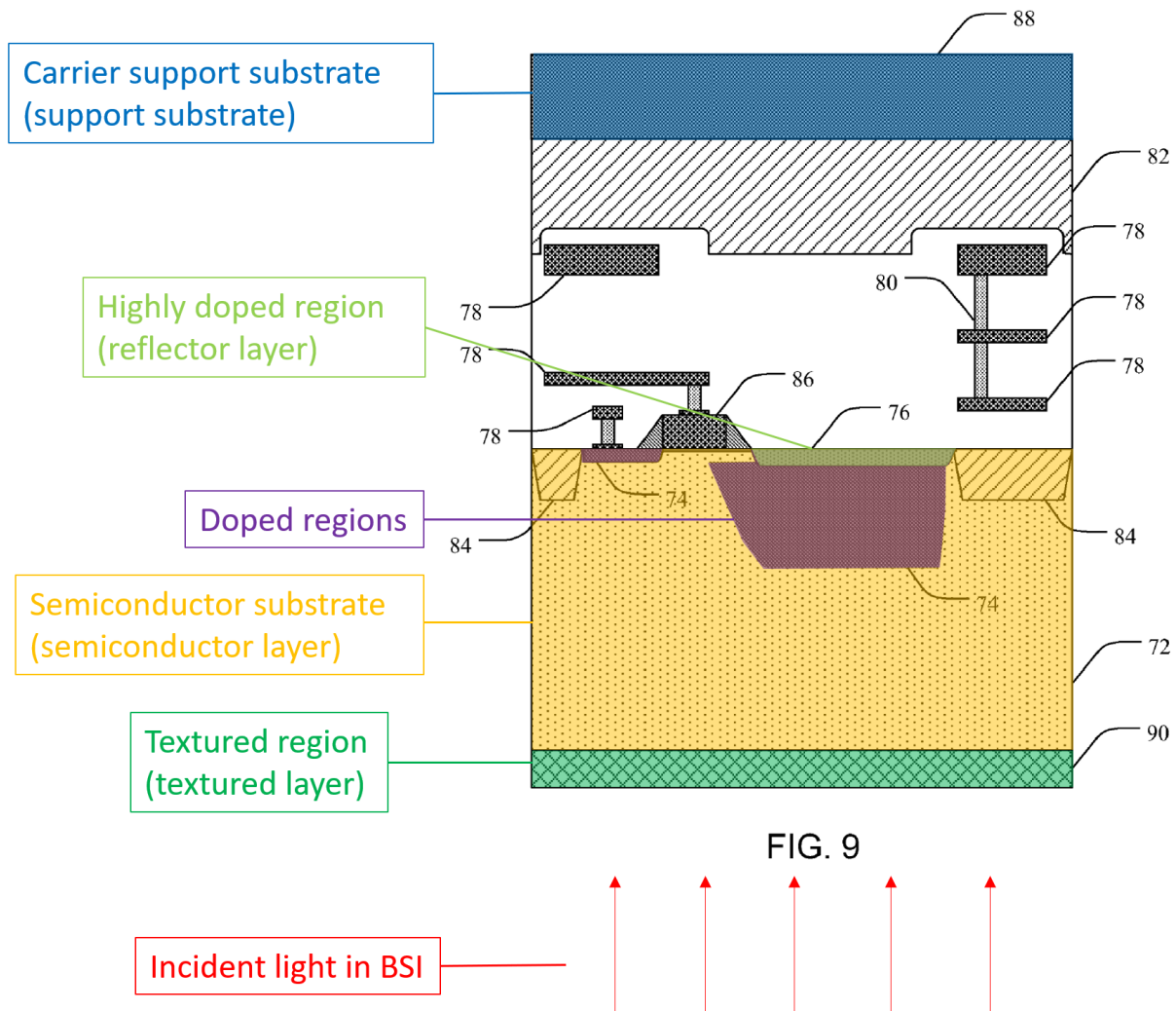
6. Claim 6

a) “The device of claim 2, further comprising a reflector layer disposed between the textured layer and the support substrate.”

118. Haddad138 discloses this limitation, or at a minimum, renders this limitation obvious under Patent Owner's proposed construction in the Related Case.

119. In the Related Case, I understand that Petitioner proposed that the term “the textured layer” is indefinite because it lacks antecedent basis. Ex-1013, 5. I understand that Patent Owner proposed that the term means the “textured region.” Ex-1014, 3.

120. Figure 9 depicts a highly doped region 76 (i.e., the claimed reflector layer) disposed between the textured region 90 (i.e., the claimed textured layer) and the support substrate. Haddad138, [0086]-[0087].



Haddad138, Fig. 9 (annotated).

121. Haddad138 discloses that the highly doped region 76 can have “textured surface features.” Haddad138, [0084]. Such features can “diffuse and **reflect** electromagnetic radiation.” Haddad138, [0066]; *see also* Haddad138, [0093] (“A textured region 156 can be coupled to the semiconductor substrate 72 opposite the lens in order to provide diffusive scattering and **reflection** of the incident electromagnetic radiation that passes through to the front side of the pixel”). Therefore, the part of the semiconductor substrate containing the highly doped region 76 corresponds to the claimed reflector layer.

122. Alternatively, it would have been obvious to add a reflecting layer above the highly doped region 76, i.e., between the textured layer and the support substrate, as required by this limitation. One of Haddad138’s provisional applications, to which Haddad138 claims priority and incorporates by reference, discloses placing a reflecting layer 234 above a highly doped region 206 in a backside illuminated device. Haddad138-Provisional004, 4-5, 8.

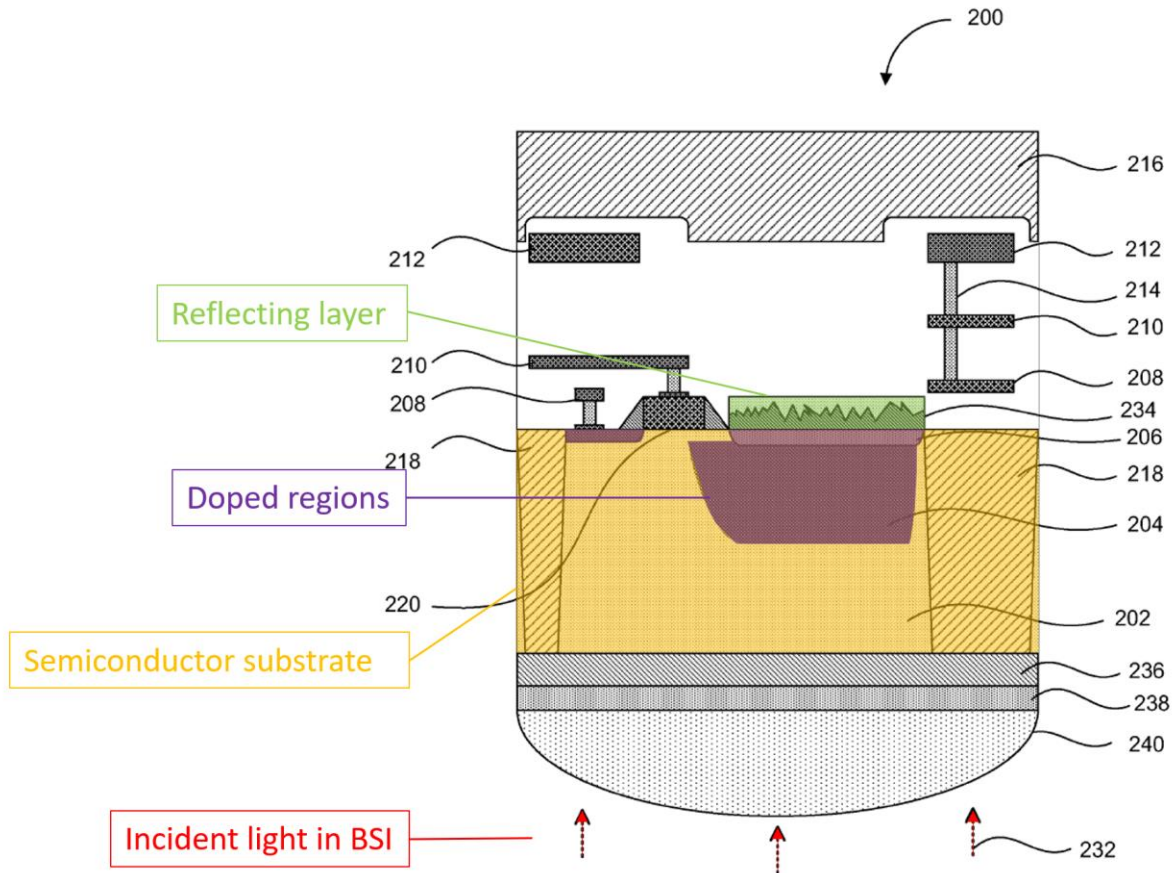
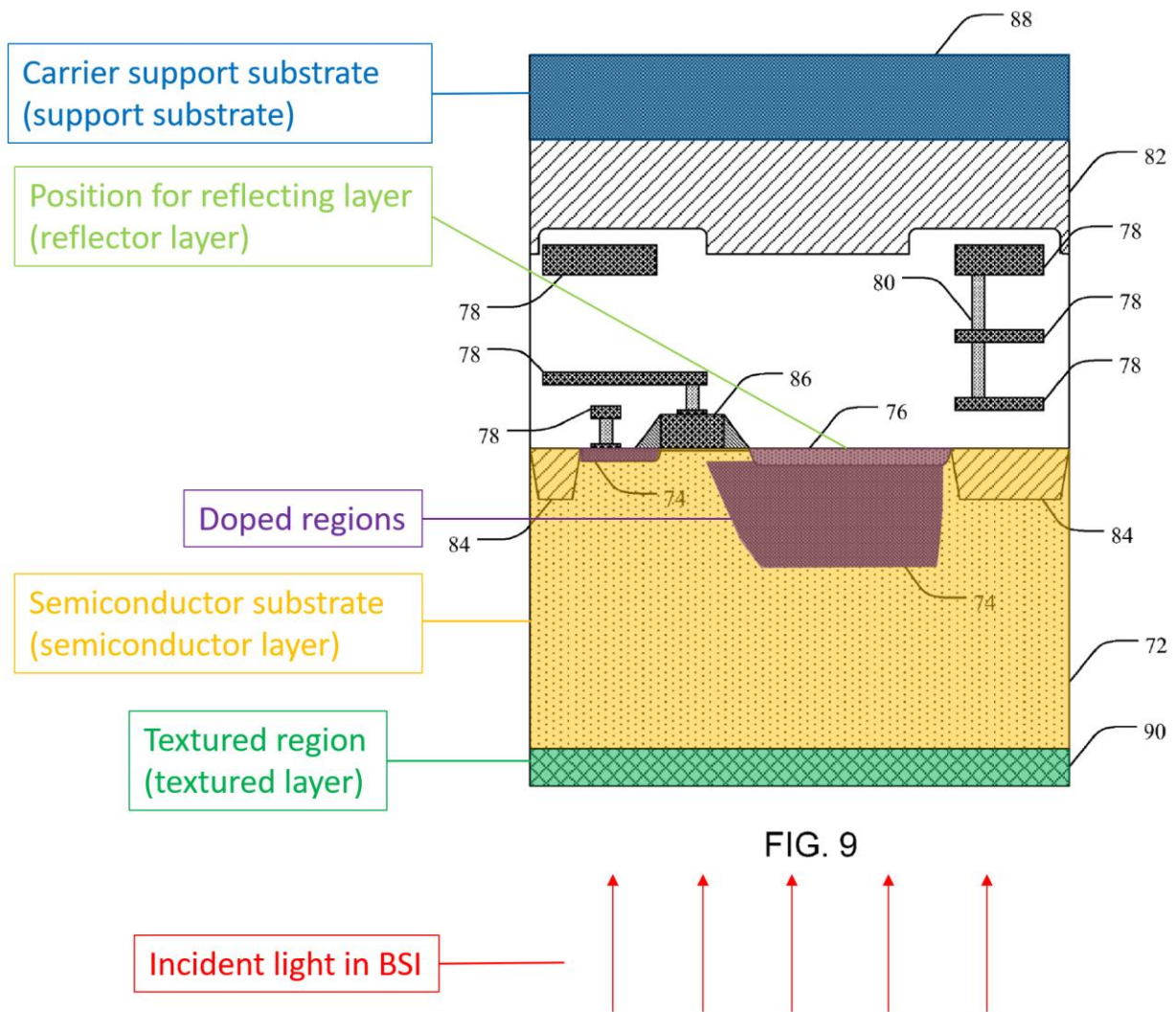


FIG. 9

Haddad138-Provisional004, Fig. 9.

123. It would have been obvious to add the Haddad138 provisional application's reflecting layer 234 to Haddad138's Figure 9 device. Haddad138's provisional application teaches that the reflecting layer "give[s] diffusive scattering and reflection of the incident light." Haddad138-Provisional004, 8. "This can result in the incident light being confined in a cavity by reflections on all sides and a maximum possible absorption of particularly the longer wavelengths not strongly absorbed by the silicon." Haddad138-Provisional004, 8. Haddad138 teaches that

increased absorption of incident light increases quantum efficiency, Haddad138, [0063], and that “[a]ny increase in the quantum efficiency makes a large difference in the signal to noise ratio.” Haddad138, [0050].



Haddad138, Fig. 9 (annotated).

124. In a BSI configuration, incident light enters the device from the bottom through the textured region 90 into the semiconductor substrate 72. See Haddad138, [0049] (“It should also be noted that the photosensitive diode can be configured with

a BSI architecture, and thus electromagnetic radiation would enter the semiconductor substrate from the direction of the textured region.”). Some light would be absorbed by the semiconductor substrate 72, but some light may travel past the semiconductor substrate 72 despite the reflecting property of the highly doped region 76. The added reflecting layer would reflect some of the light that travels past the semiconductor substrate 72 back towards the semiconductor substrate 72 for an additional opportunity for the semiconductor substrate 72 to absorb the light, increasing the quantum efficiency.

125. Adding a reflecting layer would have been a use of known technique (i.e., the use of a reflecting layer) to improve similar devices (i.e., Haddad138’s Figure 9 device and Haddad138’s provisional application’s Figure 9 device) in the same way. Haddad138’s Figure 9 device is a photodetector that can be used in a backside illuminated architecture. Haddad138, [0048], [0087], [0064]. Haddad138’s provisional application’s Figure 9 device is a backside illuminated photodetector that is similar to Haddad138’s Figure 9 device. *Compare* Haddad138, Fig. 9 with Haddad138-Provisional004, Fig. 9; *see also* Haddad138-Provisional004, 2, 8. It would also have been combining prior art elements (i.e., Haddad138’s Figure 9 device and Haddad138 Provisional Application’s reflecting layer) according to known methods to yield predictable results. As discussed above, Haddad138 teaches the predictable benefits of using a reflecting layer. Haddad138-Provisional004, 2, 8.

126. A POSITA would have had a reasonable expectation of success. It would have been well within the abilities of a POSITA to add a reflecting layer to Haddad138's Figure 9 device, given that it would have involved routine manufacturing steps that Haddad138 was already using. *See, e.g.*, Haddad138-Provisional004, 8; Haddad138, [0093].

127. Therefore, Haddad138 discloses this limitation, or at a minimum, renders this limitation obvious under Patent Owner's proposed construction in the Related Case.

7. Claim 7

a) "The device of claim 1, further comprising deep trench isolation for isolating the device."

128. Haddad138 discloses this limitation, or at a minimum, renders this limitation obvious.

129. Figure 9 depicts trench isolation 84. Haddad138, [0085].

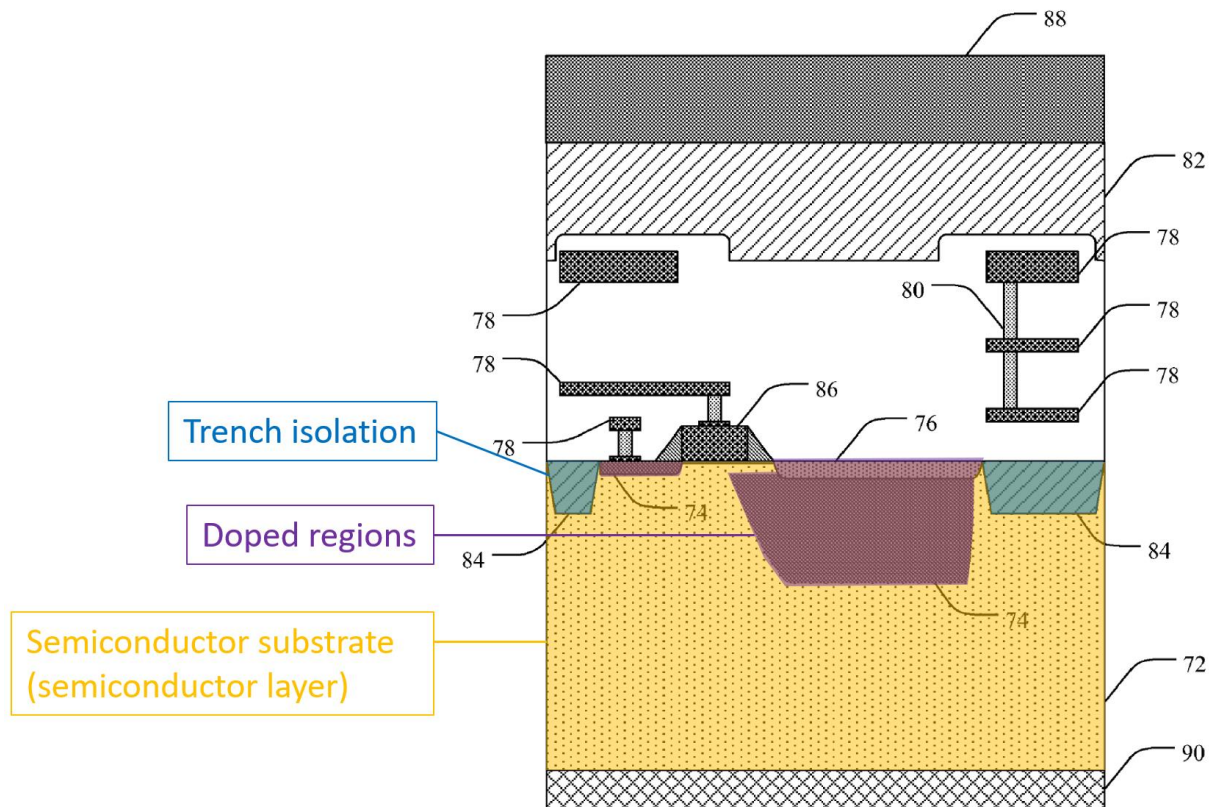


FIG. 9

Haddad138, Fig. 9 (annotated).

130. Haddad138 discloses that the trench isolation can be deep, as required by this limitation. Haddad138, [0085]; *see also* Haddad138-Provisional004, 5 (“The trench isolation can be shallow or deep trench isolation”).

131. Haddad138’s deep trench isolation can reduce optical and electrical crosstalk, i.e., isolate the device, as required by this limitation. Haddad138, [0085]; *see also* Haddad138-Provisional004, 5 (“The isolation layer can be configured to reflect the incident light until it is absorbed, thereby increas[ing] the effective absorption length of the device.”).

132. Therefore, Haddad138 discloses this limitation, or at a minimum, renders this limitation obvious.

8. Claim 8

- a) **“The device of claim 7, wherein said deep trench isolation provides light trapping functionality.”**

133. Haddad138 discloses this limitation.

134. Haddad138’s deep trench isolation can reduce optical crosstalk and “reflect incident light until it is absorbed,” i.e., provide light trapping functionality, as required by this limitation. Haddad138, [0085]; *see also* Haddad138-Provisional004, 5 (“The isolation layer can be configured to reflect the incident light until it is absorbed, thereby increas[ing] the effective absorption length of the device.”).

9. Claim 9

- a) **“The device of claim 1, wherein the semiconductor layer is single crystal silicon.”**

135. Haddad138 discloses this limitation.

136. Haddad138 discloses that “[a] variety of semiconductor materials are contemplated for use,” including “monocrystalline silicon” (i.e., the claimed single crystal silicon). Haddad138, [0052].

10. Claim 10

- a) **“The device of claim 1, wherein the semiconductor layer comprises silicon and germanium.”**

137. Haddad138 discloses this limitation.

138. Haddad138 discloses that “[a] variety of semiconductor materials are contemplated for use,” including “silicon,” “germanium,” and “silicon germanium.” Haddad138, [0052].

11. Claim 11

a) **“The device of claim 1, wherein the surface features are formed in the semiconductor layer.”**

139. Haddad138 discloses this limitation.

140. Haddad138 discloses that its “textured region can include surface features,” Haddad138, [0063], and that “the textured region can be positioned on a surface of the semiconductor substrate.” Haddad138, [0005]. Haddad138 also discloses chemically and/or structurally altering “the surface of the semiconductor material” to form “surface features appearing as microstructures or patterned areas on the surface.” Haddad138, [0070].

141. One of Haddad138’s provisional applications, to which Haddad138 claims priority and incorporates by reference, also discloses that “at least one light diffusing region [is] **formed in** or near the semiconductor substrate.” Haddad138-Provisional004, 1-2. “The light diffusing region can include light diffusing features configured [i.e., the claimed surface features] to increase the effective absorption length of the photo sensing pixel.” Haddad138-Provisional004, 2. “The light

diffusing features can be cones, pyramids, pillars, protrusions, and features that have been inverted.” Haddad138-Provisional004, 2. The light diffusing features can be created by wet or dry etches or nanoimprinting. Haddad138-Provisional004, 2.

142. Therefore, Haddad138 discloses this limitation.

12. Claim 13

a) “The device of claim 1, wherein the surface features are not uniform in height.”

143. Haddad138 discloses this limitation, or at a minimum, renders this limitation obvious.

144. Haddad138 incorporates U.S. Patent No. 7,442,629 (Mazur) by reference. Haddad138, [0069].

145. Mazur discloses “spikes” (i.e., the claimed surface features) with “a *typical* height of about 500 nm” in Figures 5A and 5B. Ex-1025, 6:3-8.

FIG. 5A

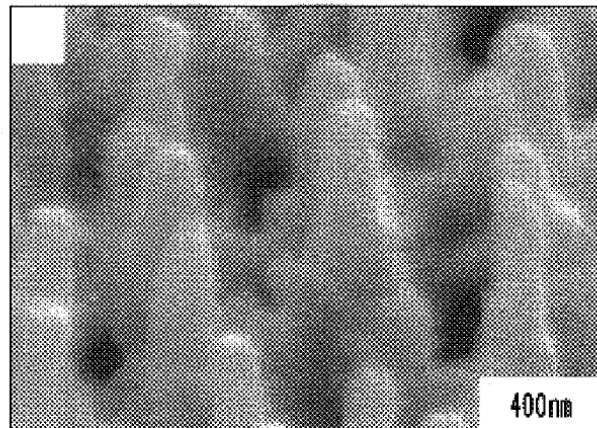
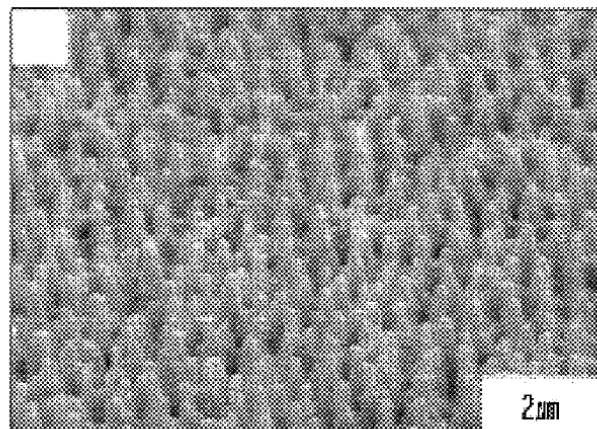


FIG. 5B

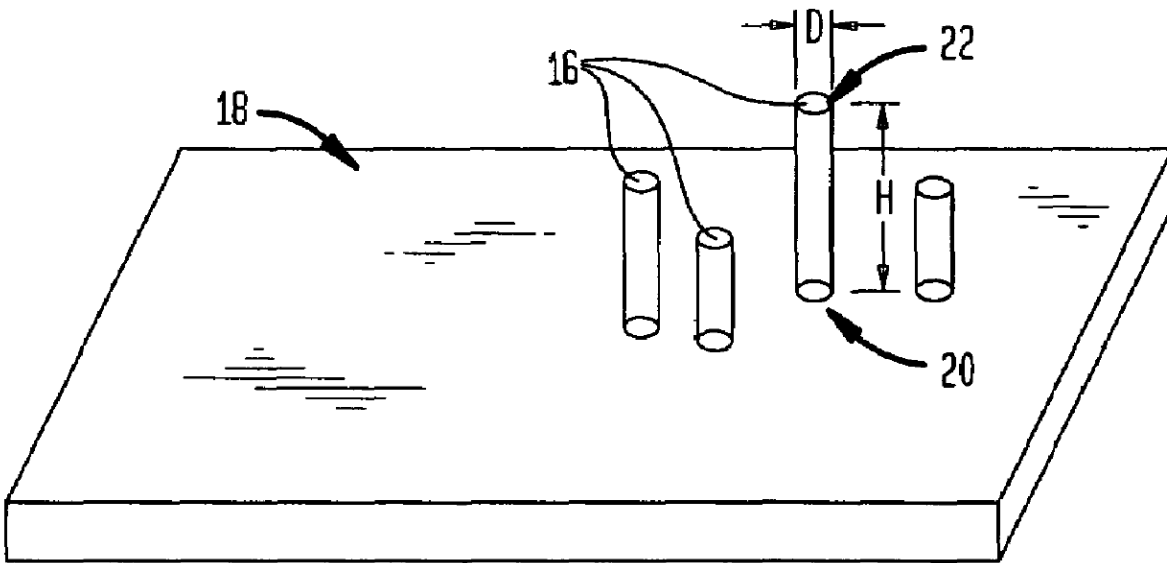


Ex-1025, Figs. 5A & 5B.

146. As shown in Figures 5A and 5B, the surface features exhibit subtle variations in height, i.e., the surface features are not uniform in height, as required by this limitation.

147. Figure 2 of Mazur schematically depicts these surface features. Ex-1025, 4:19-21.

FIG. 2



Ex-1025, Fig. 2. Although the spikes are “shown only for illustrative purposes and are not intended to indicate actual density, size or shape,” Ex-1025, 4:21-24, they accurately depict the variations in height, Ex-1025, 4:30-33 (disclosing that the surface features have an “average height” in a “range of about 200 nm to about 1 micrometer”).

148. Therefore, Haddad138 discloses this limitation.

13. Claim 14

- a) **“The device of claim 1, wherein said first bonding layer comprises any of silicon oxide, silicon nitride and amorphous silicon.”**

149. Haddad138 discloses, or at a minimum, renders this limitation obvious.

150. As discussed above regarding limitation 1[d], Haddad138 discloses a bonding layer that is disposed between the semiconductor layer and the support

substrate. It would have been obvious to use silicon oxide or silicon nitride as the bonding layer because they can be easily polished and bonded. Ex-1026, 228 (“Materials that are too rough or difficult to polish may be covered by process-compatible intermediate layers such as spun-on or chemical vapor-deposited **silicon dioxide or silicon nitride, which may be easily polished and bonded.**”).

151. It would have been obvious to apply the known technique of using silicon oxide or silicon nitride as bonding layers to Haddad138’s device to yield predictable results. Silicon oxide and silicon nitride were routinely used as bonding layers. *See, e.g.*, Ex-1026, 216 (“SOI [silicon-on-insulator] structures consist of a thin, top layer of single-crystal silicon, a layer of silicon dioxide (SiO₂), and a silicon handle substrate that acts as mechanical support.”); Ex-1027, [0032] (“The bonding layer 9 is, for example, formed of at least any one of a silicon oxide film (SiO₂), a silicon nitride film (SiN_x) ... as a single layer or a plurality of stacked layers.”); Ex-1028, 317. The use of silicon oxide and silicon nitride would have yielded predictable results because they were commonly used in semiconductor manufacturing and their properties were well known. *See, e.g.*, Ex-1026, 228; Ex-1020, 155-162.

152. A POSITA would have had a reasonable expectation of success. It would have been well within the abilities of a POSITA to use silicon oxide and silicon nitride because the manufacturing methods were well known. *See, e.g.*, Ex-

1020, 155-162. Using silicon oxide and silicon nitride for bonding would have involved routine semiconductor manufacturing steps. *See, e.g.*, Ex-1020, 155-162.

153. Therefore, Haddad138 discloses, or at a minimum, renders this limitation obvious.

14. Claim 15

- a) **“The device of claim 1, wherein said semiconductor layer has a thickness in a range of about 1 micron to about 10 microns.”**

154. Haddad138 discloses this limitation.

155. Haddad138 discloses a semiconductor material (i.e., the claimed semiconductor layer) with “a thickness of from about 1 μm to about 10 μm .” Haddad138, [0055].

15. Claim 16

- a) **“The device of claim 15, wherein the device exhibits a quantum efficiency of at least about 35% for electromagnetic radiation at a wavelength of about 940 nm.”**

156. Haddad138 discloses this limitation, or at a minimum, renders this limitation obvious.

157. Like the '737 patent, Haddad138 discloses using a textured region in a photodetector to increase quantum efficiency, particularly for infrared light, Haddad138, [0065], which includes light with a wavelength of 940 nm, Ex-1029, 807. A POSITA would have known that the increased quantum efficiency is at least

about 35% for electromagnetic radiation at a wavelength of about 940 nm, as required by this limitation. At a minimum, it would have been obvious for a POSITA to ensure that Haddad138's device achieves a quantum efficiency of at least about 35% for electromagnetic radiation at a wavelength of about 940 nm, because as Haddad138 teaches, "[a]ny increase in the quantum efficiency makes a large difference in the signal to noise ratio." Haddad138, [0050].

158. A POSITA would have had a reasonable expectation of success in achieving a quantum efficiency of at least about 35% for electromagnetic radiation at a wavelength of about 940 nm. First, this understanding is consistent with the disclosure of the '737 patent, which does not identify any exact combination of the disclosed features that achieves the required quantum efficiency, but rather, assumes that a POSITA would know how to achieve the claimed quantum efficiency.

159. Second, Jiang shows that a similar device has a quantum efficiency well over the claimed 35%, at around 70% for electromagnetic radiation at a wavelength of about 940 nm. Jiang, 1:32-35, 16:19-23.

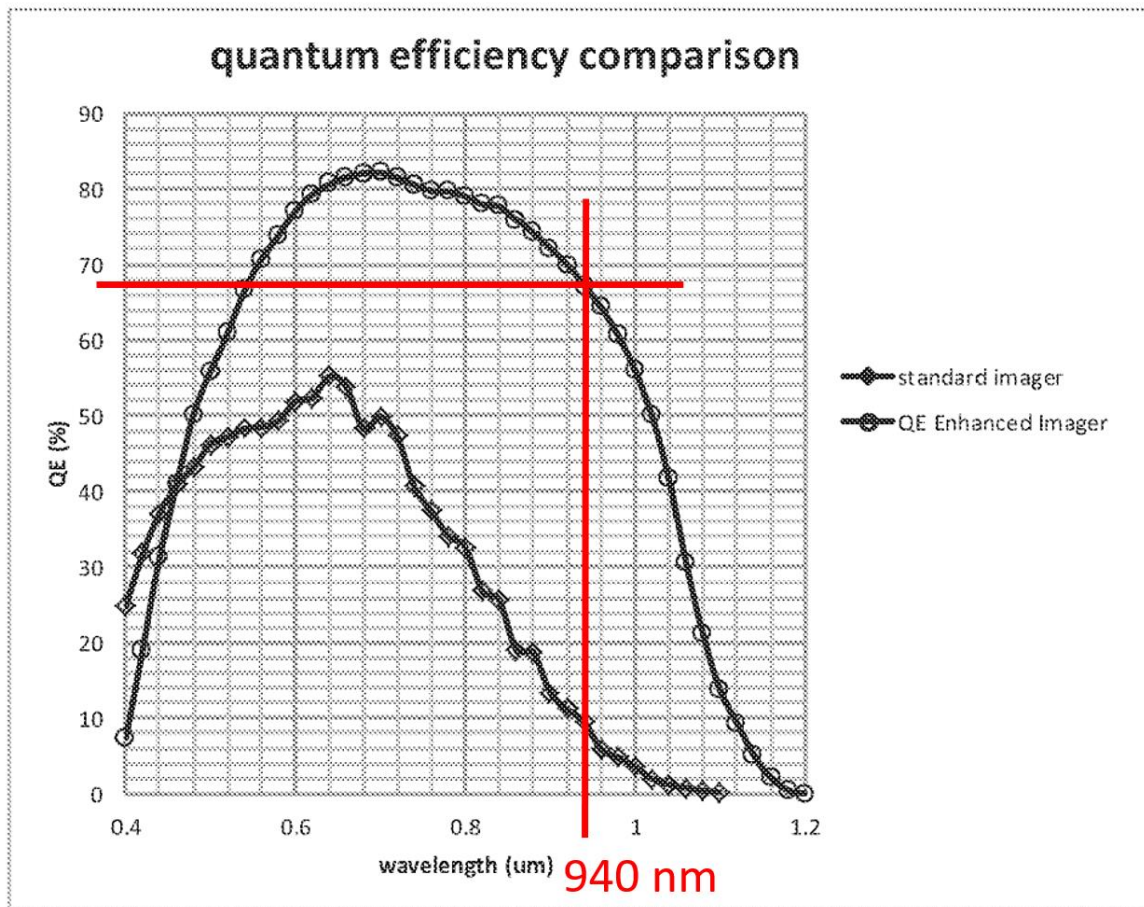


FIG. 15

Jiang, Fig. 15 (annotated). Jiang incorporates Haddad138's device by reference and discloses that Jiang's and Haddad138's devices have the same "light absorbing properties and elements." Jiang, 13:32-14:2. Like Haddad138, Jiang discloses enhancing quantum efficiency by using a textured region. Jiang, 1:30-34. Like Haddad138's textured region, Jiang's textured region can be on the light incident side. Jiang, 19:15-19. And like Haddad138's textured region, Jiang's textured region can be formed by chemical etching. Jiang, 5:13-17.

160. Therefore, Haddad138 discloses this limitation, or at a minimum, renders this limitation obvious.

16. Claim 18

- a) **“The device of claim 1, wherein said plurality of surface features have a height in a range of about 50 nm to about 2 microns.”**

161. Haddad138 discloses this limitation, or at a minimum, renders this limitation obvious.

162. As a preliminary matter, the claimed range of about 50 nm to about 2 microns does not produce any new and unexpected result.

163. Haddad138 discloses that “the [surface] features or microstructures can be on the order of 50 nm to 20 μ m in size,” which fully encompasses the claimed range. Haddad138, [0070]. More specifically, Haddad138 discloses that “a surface can be *several hundred nanometers* thick,” which is within the claimed range. Haddad138, [0032].

164. Therefore, Haddad138 discloses this limitation, or at a minimum, renders this limitation obvious.

17. Claim 19

- a) **“The device of claim 1, wherein said plurality of surface features have a height in a range from about 0.35 microns to about 0.7 microns.”**

165. Haddad138 discloses this limitation, or at a minimum, renders this limitation obvious.

166. As a preliminary matter, the claimed range of from about 0.35 microns to about 0.7 microns does not produce any new and unexpected result.

167. Haddad138 discloses that “the [surface] features or microstructures can be on the order of 50 nm to 20 μ m in size,” which fully encompasses the claimed range of 350 nm to 700 nm. Haddad138, [0070]. More specifically, Haddad138 discloses that “a surface can be *several hundred nanometers* thick,” which is within the claimed range. Haddad138, [0032].

168. Therefore, Haddad138 discloses this limitation, or at a minimum, renders this limitation obvious.

18. Claim 22

- a) **“The device of claim 1, wherein said textured region increases optical absorption of the semiconductor layer over an electromagnetic spectrum range of at least about 700 nm to about 1100 nm.”**

169. Haddad138 discloses this limitation.

170. One of Haddad138’s provisional applications, to which Haddad138 claims priority and incorporates by reference, discloses that the “net result” of using its light diffusing regions (i.e., the claimed textured regions) is “the photosensing pixel can absorb light having a wavelength in the range of about 400nm to about 1200nm,”

which includes the claimed range of about 700 nm to about 1100 nm. Haddad138-Provisional004, 6. “This is accomplished by internal reflection and increasing the effective absorption length to be greater than the thickness of the semiconductor substrate.” Haddad138-Provisional004, 6.

171. Moreover, Haddad138 discloses that, unlike “[t]raditional silicon photodetecting imagers” that have trouble detecting “photons having wavelengths longer than approximately 700 nm,” Haddad138, [0044], its device is “able to absorb longer wavelengths (e.g. >1000 nm for silicon).” Haddad138, [0044]. Haddad138 also discloses that its textured region increases optical absorption of “infrared,” Haddad138, [0065], whose wavelength range includes the claimed range of about 700 nm to about 1100 nm. Ex-1029, 807 (“The region of the near infrared spectrum extends from about 700 nm (14,000 cm⁻¹) near the end of the visible region, to 2500 nm (4,000 cm⁻¹), which is the beginning of the infrared fundamental region.”).

172. Therefore, Haddad138 discloses this limitation.

19. Claim 25

a) “The device of claim 1, wherein the pattern is a non-uniform arrangement.”

173. Haddad138 discloses this limitation.

174. Mazur, which Haddad138 incorporates by reference in paragraph [0069], discloses “submicrometer beads” (i.e., the claimed surface features) that are “randomly distributed.” Ex-1025, 7:39-42.

20. Claim 32

- a) **32[pre]: “A photosensitive imager device capable of detecting visible and infrared electromagnetic radiation, comprising:”**

175. Haddad138 discloses this preamble under both Petitioner’s and Patent Owner’s proposed constructions in the Related Case.

176. See discussion above regarding 1[pre].

- b) **32[a]: “a semiconductor layer having a light incident side and an opposed side, said semiconductor layer having multiple doped regions forming at least one junction,”**

177. Haddad138 discloses this limitation.

178. See discussion above regarding limitation 1[a].

- c) **32[b]: “a textured region comprising a plurality of surface features configured to interact with incident electromagnetic radiation so as to increase the quantum efficiency of the device,”**

179. Haddad138 discloses this limitation, or at a minimum, renders this limitation obvious under Patent Owner’s proposed construction in the Related Case.

180. See discussion above regarding limitation 1[b].

- d) **32[c]: “a support substrate coupled to said semiconductor layer, and”**

181. Haddad138 discloses this limitation.

182. See discussion above regarding limitation 1[c].

e) 32[d]: “a first bonding layer disposed between the semiconductor layer and the support substrate,”

183. Haddad138 discloses this limitation.

184. See discussion above regarding limitation 1[d].

f) 32[e]: “wherein the device exhibits a quantum efficiency of at least about 35% for electromagnetic radiation at a wavelength of about 940.”

185. Haddad138 discloses this limitation, or at a minimum, renders this limitation obvious.

186. See discussion above regarding claim 16.

21. Claim 33

a) “The device of claim 32, wherein the textured region is located on the light incident side of the semiconductor layer.”

187. Haddad138 discloses this limitation.

188. See discussion above regarding claims 2 and 32.

22. Claim 34

a) “The device of claim 33, further comprising a device layer coupled to the semiconductor layer on said side opposed to the light incident side.”

189. Haddad138 discloses this limitation.

190. See discussion above regarding claims 3 and 32.

23. Claim 35

- a) **“The device of claim 33, wherein the textured region is formed by etching.”**

191. Haddad138 discloses this limitation.

192. See discussion above regarding claims 4 and 32.

24. Claim 36

- a) **“The device of claim 35, wherein said surface features comprise pyramids.”**

193. Haddad138 discloses this limitation.

194. See discussion above regarding claims 5 and 32.

25. Claim 37

- a) **“The device of claim 33, further comprising a reflector layer disposed between the textured layer and the support substrate.”**

195. Haddad138 discloses this limitation, or at a minimum, renders this limitation obvious under Patent Owner’s proposed construction in the Related Case.

196. See discussion above regarding claims 6 and 32.

26. Claim 38

- a) **“The device of claim 32, further comprising deep trench isolation for isolating the device.”**

197. Haddad138 discloses this limitation, or at a minimum, renders this limitation obvious.

198. See discussion above regarding claims 7 and 32.

27. Claim 39

- a) **“The device of claim 38, wherein said deep trench isolation provides light trapping functionality.”**

199. Haddad138 discloses this limitation.

200. See discussion above regarding claims 8 and 32.

28. Claim 40

- a) **“The device of claim 32, wherein the semiconductor layer is single crystal silicon.”**

201. Haddad138 discloses this limitation.

202. See discussion above regarding claims 9 and 32.

29. Claim 41

- a) **“The device of claim 32, wherein the semiconductor layer comprises silicon and germanium.”**

203. Haddad138 discloses this limitation.

204. See discussion above regarding claims 10 and 32.

30. Claim 42

- a) **“The device of claim 32, wherein the surface features are formed in the semiconductor layer.”**

205. Haddad138 discloses this limitation.

206. See discussion above regarding claims 11 and 32.

31. Claim 44

- a) **“The device of claim 32, wherein the surface features are not uniform in height.”**

207. Haddad138 discloses this limitation, or at a minimum, renders this limitation obvious.

208. See discussion above regarding claim 13.

209. See discussion above regarding claim 32.

210. Therefore, Haddad138 discloses this limitation, or at a minimum, renders this limitation obvious.

32. Claim 45

- a) **“The device of claim 32, wherein said first bonding layer comprises any of silicon oxide, silicon nitride and amorphous silicon.”**

211. Haddad138 discloses, or at a minimum, renders this limitation obvious.

212. See discussion above regarding claims 14 and 32.

33. Claim 46

- a) **“The device of claim 32, wherein said semiconductor layer has a thickness in a range of about 1 micron to about 10 microns.”**

213. Haddad138 discloses this limitation.

214. See discussion above regarding claims 15 and 32.

34. Claim 48

- a) **“The device of claim 32, wherein said plurality of surface features have a height in a range of about 50 nm to about 2 microns.”**

215. Haddad138 discloses this limitation, or at a minimum, renders this limitation obvious.

216. See discussion above regarding claims 18 and 32.

35. Claim 49

- a) **“The device of claim 32, wherein said plurality of surface features have a height in a range from about 0.35 microns to about 0.7 microns.”**

217. Haddad138 discloses this limitation, or at a minimum, renders this limitation obvious.

218. See discussion above regarding claims 19 and 32.

36. Claim 52

- a) **“The device of claim 32, wherein said textured region increases optical absorption of the semiconductor layer over an electromagnetic spectrum range of at least about 700 nm to about 1100 nm.”**

219. Haddad138 discloses this limitation.

220. See discussion above regarding claims 22 and 32.

37. Claim 55

- a) **“The device of claim 32, wherein the surface features are arranged according to a pattern that is a non-uniform arrangement.”**

221. Haddad138 discloses this limitation.

222. See discussion above regarding claims 25 and 32.

B. Ground A-2: Claims 1, 12-13, 21, 24, 43-44, 51, and 54 Are Obvious Based on Haddad138 and Baggenstoss

1. Claim 1

223. To the extent the Board finds that Haddad138 does not anticipate or render obvious claim 1 because it does not disclose that “the surface features are arranged according to a pattern,” Haddad138 in view of Baggenstoss renders claim 1 obvious under Patent Owner’s proposed construction in the Related Case.

224. In the Related Case, I understand that Petitioner proposed that the term “the surface features are arranged according to a pattern” is indefinite. Ex-1013, 4. I understand that Patent Owner proposed that the term has a plain and ordinary meaning and that, to the extent a construction is required, it means “features coincident with at least one surface that are arranged in a repeating manner.” Ex-1014, 4.

225. As discussed above regarding limitation 1[b] in Ground A-1, Haddad138 discloses a photodetector with a textured region. Haddad138, [0084], [0087], [0064]. Haddad138 discloses that its textured region can include surface features. Haddad138, [0063].

226. Similarly, Baggenstoss discloses a photodetector with a grated interface formed by trenches 144 (i.e., the claimed surface features arranged according to a pattern). Baggenstoss, [0031]-[0032], [0009].

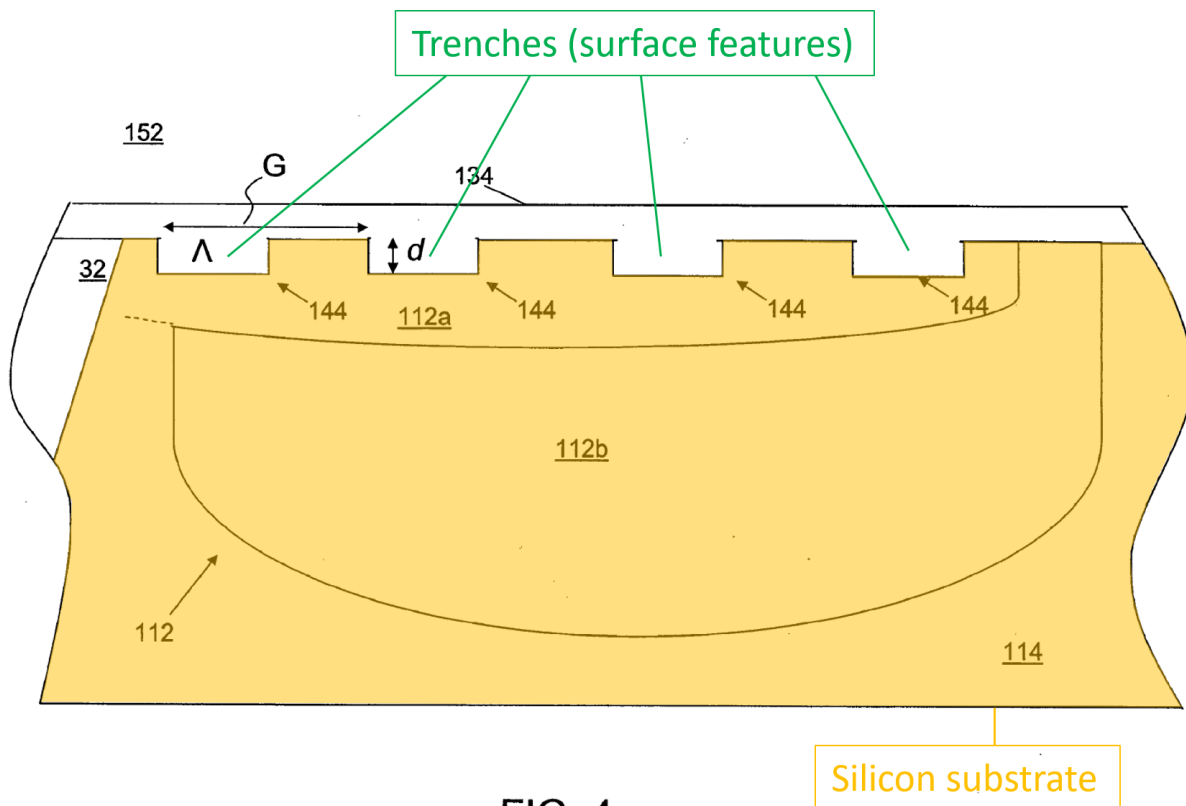


FIG. 4

Baggenstoss, Fig. 4 (annotated).

227. “Each grating (measured as the distance from the beginning of one trench 144 to the beginning of the next trench 144 (shown by arrow G)) has a predetermined period that is represented by Λ .” Baggenstoss, [0032]. The predetermined period Λ can be, for example, 340 nm. Baggenstoss, [0034]. Baggenstoss’s trenches are features coincident with at least one surface that are arranged in a repeating manner, and are an example of a pattern provided by the provisional application for the ’737 patent. Ex-1003, 13:3-4 (“[A]s is shown in FIG. 5 for example, the shallow trench isolation can

be a ***uniform grid pattern*** comprised of [trenches] that form ***a series of spaces and lines*** or pillars.”).

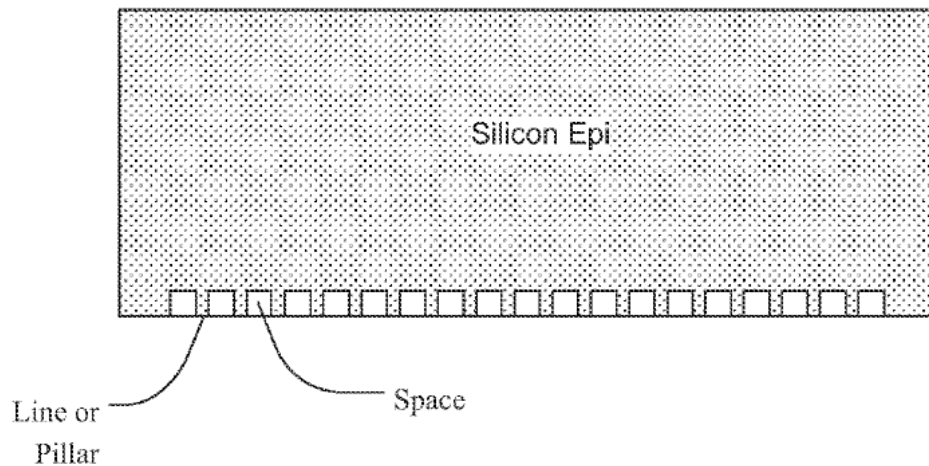


FIG. 5

Ex-1003, Fig. 5.

228. The trenches 144 are arranged in a repeating manner, as required by Patent Owner’s proposed construction in the Related Case.

229. It would have been obvious to use Baggenstoss’s trenches 144 as Haddad138’s surface features, with a reasonable expectation of success, as discussed in Section VIII.B.10 below.

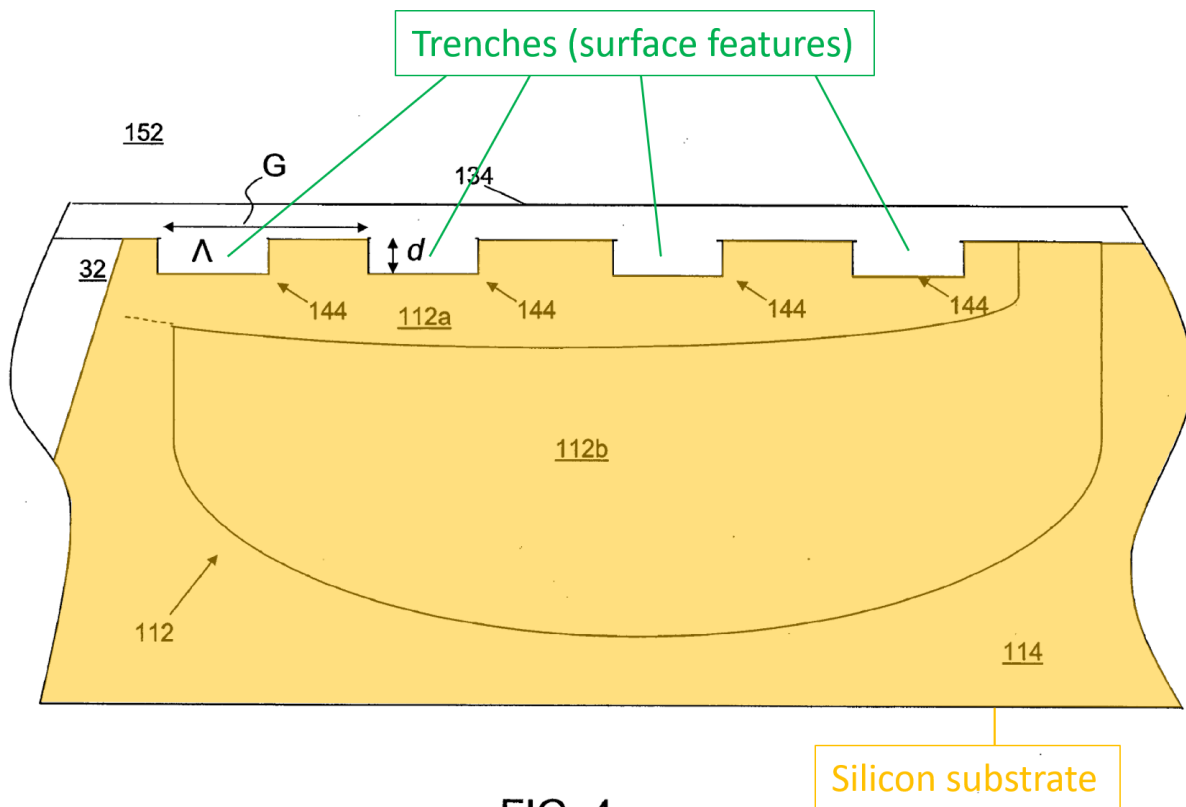
230. Therefore, Haddad138 in view of Baggenstoss renders this limitation obvious under Patent Owner’s proposed construction in the Related Case.

2. Claim 12

- a) **“The device of claim 1, wherein the surface features have a substantially uniform height.”**

231. Haddad138 in view of Baggenstoss renders this limitation obvious.

232. As discussed above regarding claim 1, Figure 4 of Baggenstoss depicts a grated interface formed by trenches 144 (i.e., the claimed surface features). Baggenstoss, [0031]-[0032].



Baggenstoss, Fig. 4 (annotated).

233. Baggenstoss discloses that the trenches 144 have a predetermined depth (i.e., the claimed height), represented by d in Figure 4. Baggenstoss, [0032]. The predetermined depth d can be, for example, a constant depth of 100 nm. Baggenstoss,

[0034]-[0035]. Baggenstoss's surface features, therefore, have a substantially uniform height, as required by this limitation.

234. It would have been obvious to use Baggenstoss's trenches 144 as Haddad138's surface features, with a reasonable expectation of success, as discussed in Section VIII.B.10 below.

235. Therefore, Haddad138 in view of Baggenstoss renders this limitation obvious.

3. Claim 13

a) “The device of claim 1, wherein the surface features are not uniform in height.”

236. Haddad138 in view of Baggenstoss renders this limitation obvious.

237. In another embodiment, Baggenstoss discloses a pixel cell with a “blazed (or step-wise)” gratings formed of trenches 244 (i.e., the claimed surface features). Baggenstoss, [0042].



FIG. 11

Baggenstoss, Fig. 11 (annotated).

238. As shown in Figure 11, the trenches 244 have two different depths (i.e., the claimed heights). Baggenstoss, [0043]. Thus, the surface features are not uniform in height, as required by this limitation.

239. Baggenstoss discloses that its trenches can be formed by chemical etching. Baggenstoss, [0038], [0043]. Typically, two masks would be required to etch the two different depths of the trenches 244.

240. It would have been obvious to use Baggenstoss's trenches 244 as Haddad138's surface features, with a reasonable expectation of success, as discussed in Section VIII.B.10 below.

241. Therefore, Haddad138 in view of Baggenstoss renders this limitation obvious.

4. **Claim 21**

a) **“The device of claim 1, wherein said plurality of surface features comprise multiple etched levels.”**

242. Haddad138 in view of Baggenstoss renders this limitation obvious.

243. As discussed above regarding claim 13, Baggenstoss discloses trenches 244 (i.e., the claimed surface features) with two different depths. Baggenstoss, [0043].

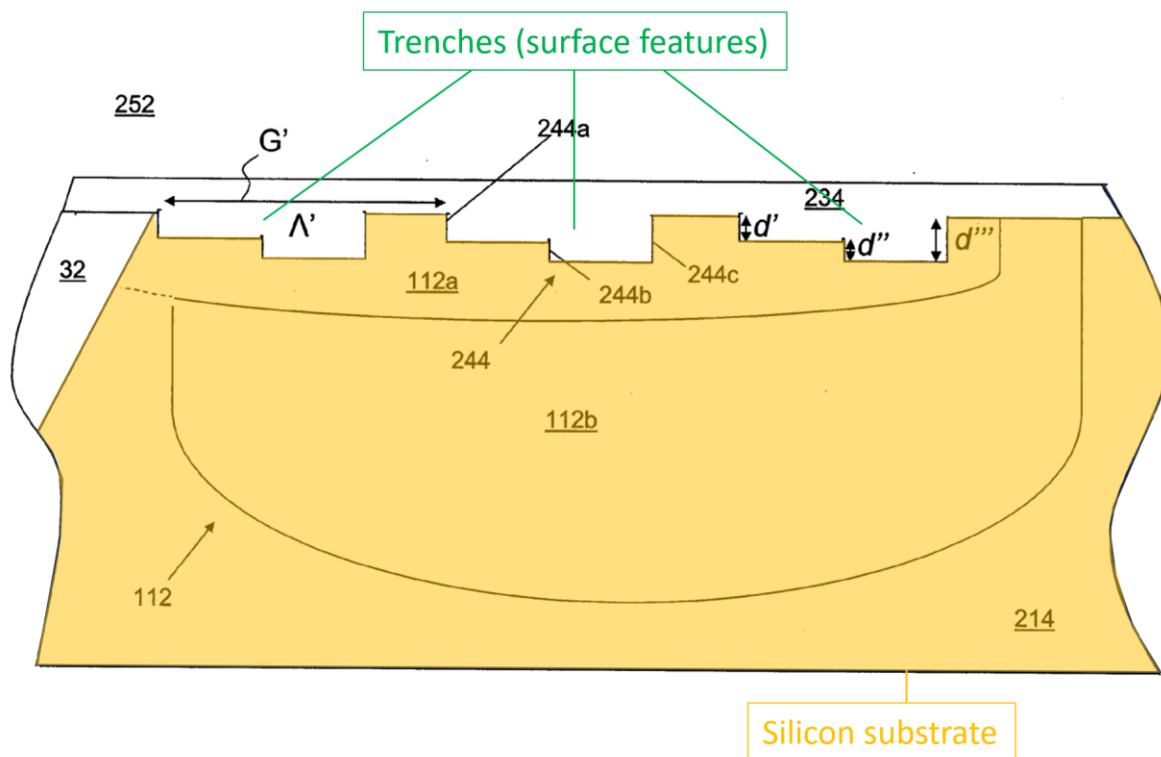


FIG. 11

Baggenstoss, Fig. 11 (annotated).

244. The different depths correspond to the claimed multiple etched levels because Baggenstoss's trenches 244 can be formed via chemical etching. Baggenstoss, [0038], [0043]. Typically, two masks would be required to etch the two different depths of the trenches 244.

245. It would have been obvious to use Baggenstoss's trenches 244 as Haddad138's surface features, with a reasonable expectation of success, as discussed in Section VIII.B.10 below.

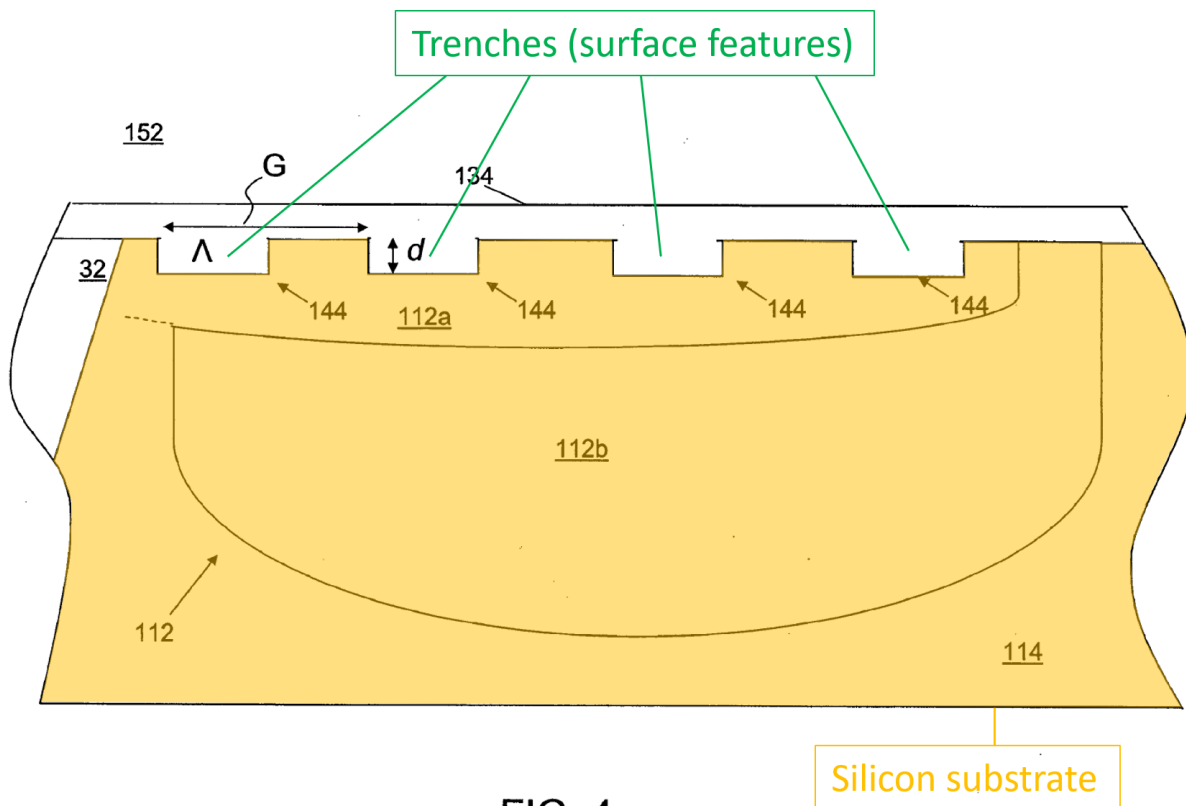
246. Therefore, Haddad138 in view of Baggenstoss renders this limitation obvious.

5. Claim 24

a) “The device of claim 1, wherein the pattern is an at least substantially uniform grid.”

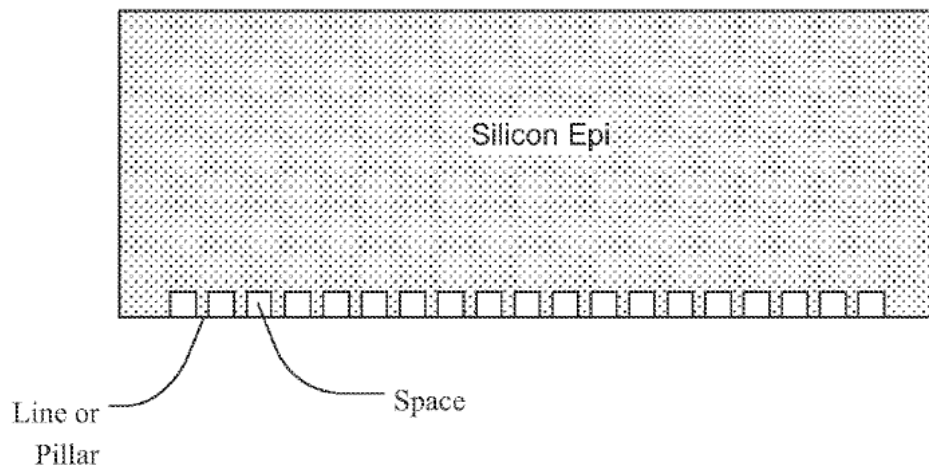
247. Haddad138 in view of Baggenstoss renders this limitation obvious.

248. As discussed above regarding claim 1, Figure 4 of Baggenstoss depicts a grated interface formed by trenches 144 (i.e., the claimed surface features). Baggenstoss, [0031]-[0032].



Baggenstoss, Fig. 4 (annotated).

249. “Each grating (measured as the distance from the beginning of one trench 144 to the beginning of the next trench 144 (shown by arrow G) has a predetermined period that is represented by Λ ,” i.e., the trenches form the claimed substantially uniform grid. Baggenstoss, [0032]. The provisional application for the ’737 patent identifies such gratings as an example of a “uniform grid pattern.” Ex-1003, 13:3-4 (“[A]s is shown in FIG. 5 for example, the shallow trench isolation can be a **uniform grid pattern** comprised of [trenches] that form **a series of spaces and lines** or pillars.”).



Ex-1003, Fig. 5.

250. It would have been obvious to use Baggenstoss's trenches 144 as Haddad138's surface features, with a reasonable expectation of success, as discussed in Section VIII.B.10 below.

251. Therefore, Haddad138 in view of Baggenstoss renders this limitation obvious.

6. Claim 43

- a) **“The device of claim 32, wherein the surface features have a substantially uniform height.”**

252. Haddad138 in view of Baggenstoss renders this limitation obvious.

253. See discussion above regarding claims 12 and 32.

7. Claim 44

- a) **“The device of claim 32, wherein the surface features are not uniform in height.”**

254. Haddad138 in view of Baggenstoss renders this limitation obvious.

255. See discussion above regarding claims 13 and 32.

8. Claim 51

a) **“The device of claim 32, wherein said plurality of surface features comprise multiple etched levels.”**

256. Haddad138 in view of Baggenstoss renders this limitation obvious.

257. See discussion above regarding claims 21 and 32.

9. Claim 54

a) **“The device of claim 32, wherein the surface features are arranged according to a pattern that is an at least substantially uniform grid.”**

258. Haddad138 in view of Baggenstoss renders this limitation obvious.

259. See discussion above regarding claims 24 and 32.

10. Motivation to combine Haddad138 and Baggenstoss

260. It would have been obvious to combine Haddad138 with Baggenstoss.

261. A POSITA would have been motivated to use Baggenstoss’s trenches for Haddad138’s surface features. Baggenstoss teaches that its grated interface formed of trenches “allows a greater percentage of incident light to be captured, which is a vast improvement over the art.” Baggenstoss, [0014]. Baggenstoss explains that its grated interface “serves to create a hybrid index of refraction ... thereby decreasing the percentage of incident light reflection.” Baggenstoss, [0031]. With the grated interface formed of trenches 144, the incident light reflection is

“nearly eliminated” with a trench depth d of 100 nm. Baggenstoss, [0035]. The “blazed” gratings formed of trenches 244 can decrease the incident light reflection even further. Baggenstoss, [0042]-[0043]. Whether to use Baggenstoss’s trenches 144 or 244 would have depended on the particular design needs regarding the cost of manufacture and the desired amount of reduction in incident light reflection.

262. Using Baggenstoss’s trenches would have been a use of known technique to improve similar devices in the same way. Both Haddad138 and Baggenstoss disclose photodetectors. Haddad138, [0003], [0064]; Baggenstoss, [0014], [0009]. Both Haddad138 and Baggenstoss have the same goal of improving the efficiency of photodetectors in capturing incident light. Haddad138, [0063]; Baggenstoss, [0014]. Both Haddad138 and Baggenstoss achieve that goal by using a textured region including surface features. Haddad138, [0063], [0087]; Baggenstoss, [0031]-[0032], [0042]. Both Haddad138 and Baggenstoss disclose placing the textured region on the light incident side. Haddad138, [0049] (“It should also be noted that the photosensitive diode can be configured with a BSI architecture, and thus electromagnetic radiation would enter the semiconductor substrate from the direction of the textured region”); Baggenstoss, [0038], Fig. 3 (depicting light source 38 on the side of the grated interface). Like the grated interface of Baggenstoss, the textured region of Haddad138 can “enhance the absorption properties by reducing the amount of incident electromagnetic radiation that is reflected from the device.”

Haddad138-Provisional434, 5. Both Haddad138 and Baggenstoss disclose forming the surface features using chemical etching. Haddad138, [0006]; Baggenstoss, [0038].

263. It would have been a simple substitution of one known element (i.e., Haddad138's surface features) for another (Baggenstoss's trenches) to obtain predictable results. Baggenstoss teaches that incident light reflection is decreased due to its grated interface formed of trenches serving to create a "hybrid index of refraction." Baggenstoss, [0031]. Baggenstoss even provides measurements of incident light reflection based on various dimensions of its trenches and their arrangements into gratings. Baggenstoss, Figs. 5A & 5B.

264. A POSITA would have had a reasonable expectation of success. It would have been well within the abilities of a POSITA to use Baggenstoss's trenches for Haddad138's surface features, given that it would have involved routine manufacturing steps, such as chemical etching, that Haddad138 was already using for its surface features. Haddad138, [0006].

C. Ground A-3: Claims 16, 32-42, 44-46, 48-49, 52, and 55 Are Obvious Based on Haddad138 and Jiang

265. To the extent that the Board finds that Haddad138 does not disclose or render obvious a device exhibiting "a quantum efficiency of at least about 35% for electromagnetic radiation at a wavelength of about 940 nm," and that therefore,

Haddad138 does not disclose or render obvious claims 16, 32-42, 44-46, 48-49, 52, and 55, Haddad138 in view of Jiang renders them obvious.

266. Like the '737 patent, Haddad138 discloses using a textured region in a photodetector to increase quantum efficiency, particularly for infrared light, Haddad138, [0065], which includes light with a wavelength of 940 nm, Ex-1029, 807. A POSITA would have known that the increased quantum efficiency is at least about 35% for electromagnetic radiation at a wavelength of about 940 nm, as required by this limitation. At a minimum, it would have been obvious for a POSITA to ensure that Haddad138's device achieves a quantum efficiency of at least about 35% for electromagnetic radiation at a wavelength of about 940 nm, because as Haddad138 teaches, "[a]ny increase in the quantum efficiency makes a large difference in the signal to noise ratio." Haddad138, [0050]. A POSITA would have looked to Jiang's teaching that a device similar to Haddad138's device achieves a quantum efficiency well over the claimed 35%, at around 70% for electromagnetic radiation at a wavelength of about 940 nm. Jiang, 1:32-35, 16:19-23.

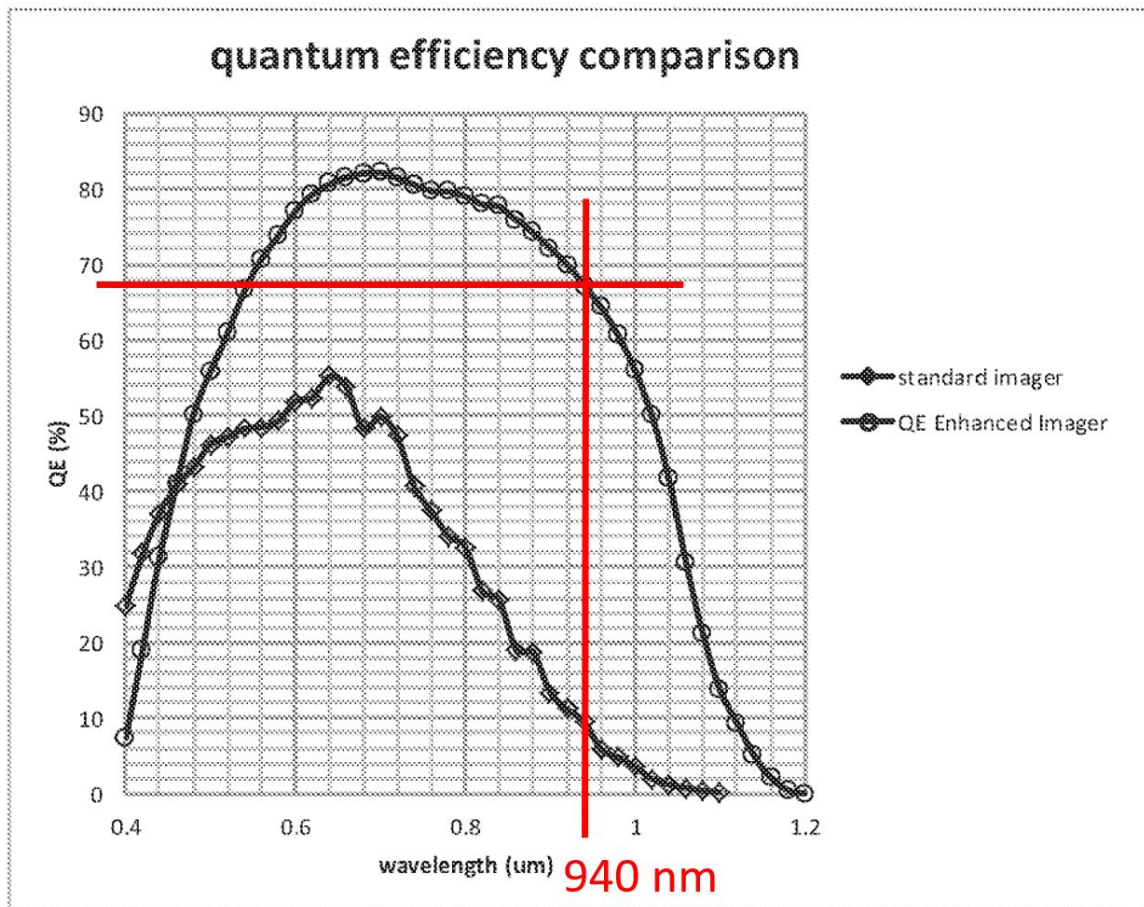


FIG. 15

Jiang, Fig. 15 (annotated).

267. Matching Jiang's quantum efficiency numbers would have involved a use of known technique to improve similar devices in the same way. Jiang incorporates Haddad138's device by reference and discloses that Jiang's and Haddad138's devices have the same "light absorbing properties and elements." Jiang, 13:32-14:2. Haddad138 discloses using a textured region in a photodetector to increase quantum efficiency, particularly for infrared light, Haddad138, [0065], which includes light

with a wavelength of 940 nm. Similarly, Jiang discloses using a textured region in a photodetector to increase quantum efficiency for infrared light. Jiang, 1:25-34. Like Haddad138's textured region, Jiang's textured region can be on the light incident side. Jiang, 19:15-19, 11:1-4. And like Haddad138's textured region, Jiang's textured region can be formed by chemical etching. Jiang, 5:13-17.

268. A POSITA would have had a reasonable expectation of success in achieving a quantum efficiency of at least about 35% for electromagnetic radiation at a wavelength of about 940 nm. First, this understanding is consistent with the disclosure of the '737 patent, which does not identify any exact combination of the disclosed features that achieves the required quantum efficiency, but rather, assumes that a POSITA would know how to achieve the claimed quantum efficiency. Second, as discussed above, Jiang has shown that a device similar to Haddad138's device achieves a quantum efficiency well over the claimed 35%. Jiang, 13:32-14:2, Fig. 15.

269. Therefore, Haddad138 in view of Jiang renders obvious claims 16, 32-42, 44-46, 48-49, 52, and 55.

D. Ground A-4: Claims 17, 20, 23, 47, 50, and 53 Are Obvious Based on Haddad138 and Alie

1. Claim 17

- a) **“The device of claim 1, wherein said bonding layer has a thickness in a range of about 30 nm to about 3 microns.”**

270. Haddad138 in view of Alie renders this limitation obvious.

271. Haddad138 discloses that “[t]he carrier substrate can be coupled to the photosensing pixel by various techniques” including “by way of a bonding layer” (i.e., the claimed first bonding layer). Haddad138, [0086].

272. Similarly, Alie disclose the use of a dielectric layer as a bonding layer. Alie, [0055], [0087], [0105]. Alie discloses that its dielectric layer can have “a thickness of from about 500 nm to about 2 microns,” which is fully encompassed by the claimed range of about 30 nm to about 3 microns. Alie, [0088].

273. It would have been obvious to combine Haddad138 with Alie, with a reasonable expectation of success, as discussed in Section VIII.D.7 below.

274. Therefore, Haddad138 in view of Alie renders this limitation obvious.

2. Claim 20

a) **“The device of claim 1, wherein said plurality of surface features are formed by using a patterned mask and photolithography followed by etching.”**

275. Haddad138 in view of Alie renders this limitation obvious.

276. Haddad138 discloses that surface features can be formed by etching. Haddad138, [0006].

277. Alie also discloses that surface features can be formed by “a selective etching technique, such as a mask, photolithography, and an etch.” Alie, [0072].

278. It would have been obvious to combine Haddad138 with Alie, with a reasonable expectation of success, as discussed in Section VIII.D.7 below.

279. Therefore, Haddad138 in view of Alie renders this limitation obvious.

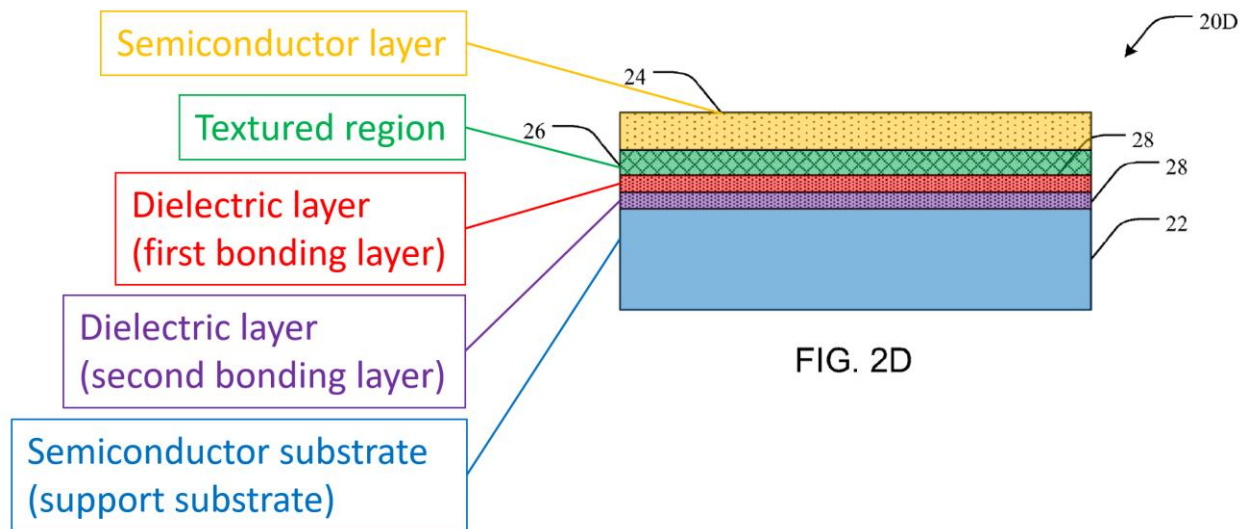
3. Claim 23

- a) **“The device of claim 1, further comprising a second bonding layer positioned between the first bonding layer and the support substrate.”**

280. Haddad138 in view of Alie renders this limitation obvious.

281. Haddad138 discloses that, during the manufacture of a photodetector, “[t]he carrier substrate can be coupled to the photosensing pixel by various techniques” including “by way of a bonding layer” (i.e., the claimed first bonding layer). Haddad138, [0086].

282. Alie also discloses using a dielectric layer as a bonding layer in a photodetector. Alie, [0055], [0006]. Alie further discloses that, instead of using just one dielectric layer for bonding, two dielectric layers can be used. Alie, [0059]. “In the case of wafer bonding, for example, a first dielectric layer can be associated with the textured layer and a second dielectric layer can be associated with the semiconductor substrate.” Alie, [0059]. “The first dielectric layer and the second dielectric layer are heated and pressed together, with or without the aid of further pressure, temperature, or plasma surface activation, to cause the dielectric layers to bond to one another, thus forming a single wafer-bonded structure.” Alie, [0059]. Figure 2D depicts the use of the second bonding layer positioned between the first bonding layer and the support substrate:



Alie, Fig. 2D (annotated).

283. It would have been obvious to combine Haddad138 with Alie, with a reasonable expectation of success, as discussed in Section VIII.D.7 below.

284. Therefore, Haddad138 in view of Alie renders this limitation obvious.

4. Claim 47

- a) **“The device of claim 32, wherein said bonding layer has a thickness in a range of about 30 nm to about 3 microns.”**

285. Haddad138 in view of Alie renders this limitation obvious.

286. See discussion above regarding claims 17 and 32.

5. Claim 50

- a) **“The device of claim 32, wherein said plurality of surface features are formed by using a patterned mask and photolithography followed by etching.”**

287. Haddad138 in view of Alie renders this limitation obvious.

288. See discussion above regarding claims 20 and 32.

6. Claim 53

- a) **“The device of claim 32, further comprising a second bonding layer positioned between the first bonding layer and the support substrate.”**

289. Haddad138 in view of Alie renders this limitation obvious.

290. See discussion above regarding claims 23 and 32.

7. Motivation to combine Haddad138 and Alie

291. It would have been obvious to combine Haddad138 with Alie. It would have been a use of known technique (i.e., Alie’s bonding layers or etching technique) to improve similar devices in the same way. Both Haddad138 and Alie are SiOnyx’s patent applications that share the same two joint inventors: Jeffrey McKee and Chintamani Palsule. Both Haddad138 and Alie concern photodetectors with textured regions that increase quantum efficiency. Haddad138, [0063]-[0064], [0087]; Alie, [0052], [0096], [0006]. The textured regions in both references include similarly shaped surface features. Haddad138, [0063] (“The surface features can be cones, pyramids, pillars, protrusions, micro lenses, quantum dots, inverted features and the like.”); Alie, [0068] (“Non-limiting examples of shapes and configurations of surface features include cones, pillars, pyramids, microlenses, quantum dots, inverted features, gratings, protrusions, sphere-like structures, and the like, including combinations thereof.”). The textured regions in both references can be formed by chemical etching. Haddad138, [0066]; Alie, [0074].

292. Both Haddad138's device and Alie's device use similar materials. *See, e.g.*, Haddad138, [0052] ("Exemplary silicon materials can include amorphous silicon (a-Si), microcrystalline silicon, multicrystalline silicon, and monocrystalline silicon, as well as other crystal types."); Alie, [0060] ("Exemplary silicon materials can include amorphous silicon (a-Si), microcrystalline silicon, multicrystalline silicon, and monocrystalline silicon, as well as other crystal types."). Both Haddad138's device and Alie's device also share similar dimensions. *See, e.g.*, Haddad138, [0055] ("the semiconductor material has a thickness of from about 1 μm to about 10 μm "); Alie, [0063] ("the semiconductor material has a thickness of from about 1 μm to about 10 μm "). In view of the above, where Haddad138 is silent on certain details regarding the bonding layers and the etching technique used, a POSITA would have looked to Alie for such details and used them for Haddad138's device with predictable results.

293. A POSITA would have had a reasonable expectation of success. It would have been well within the abilities of a POSITA to use Alie's bonding layers and etching technique for Haddad138's device, given that it would have involved routine manufacturing steps that Alie had already used in its device with predictable results.

E. Ground A-5: Claims 25 and 55 Are Obvious Based on Haddad138 and Haddad204

1. Claim 25

a) “The device of claim 1, wherein the pattern is a non-uniform arrangement.”

294. Haddad138 in view of Haddad204 renders this limitation obvious.

295. As discussed above regarding limitation 1[b] in Ground A-1, Haddad138 discloses a photodetector with a textured region. Haddad138, [0087], [0064]. Haddad138 discloses that its textured region can include surface features such as pillars. Haddad138, [0006], [0063].

296. Similarly, Haddad204 discloses a photodetector with a textured region including surface features such as pillars. Haddad204, [0073], [0053]. Importantly, Haddad204 discloses “a plurality of pillars of variable sizes ... arranged in a non-uniform array.” Haddad204, [0112]. Figure 9a shows a top view and Figure 9b shows a cross-sectional view of such “pillars etched into a semiconductor material.” Haddad204, [0112].

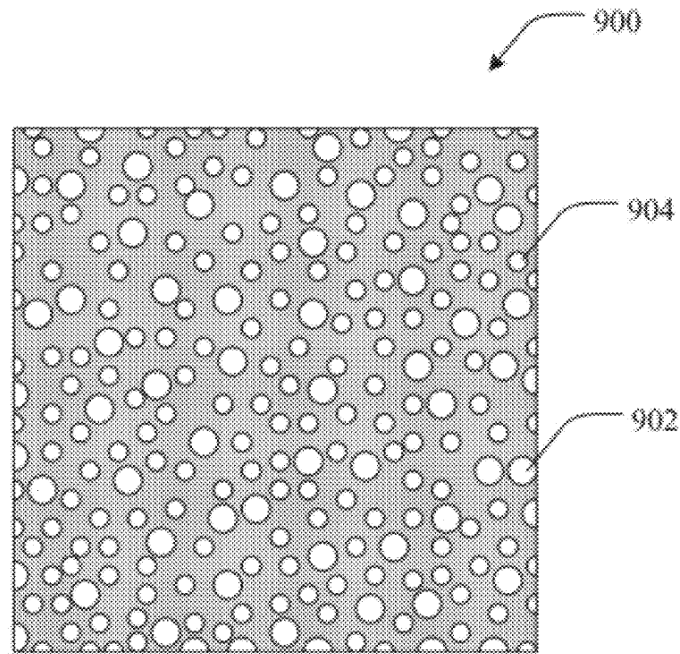


FIG. 9a

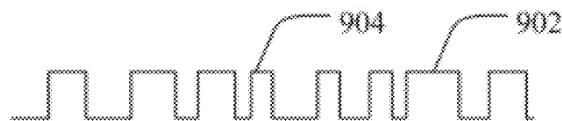


FIG. 9b

Haddad204, Figs. 9a-b.

297. It would have been obvious to use Haddad204's non uniform arrangement of pillars for Haddad138's arrangement of pillars because Haddad204 teaches that its surface features "increase the effective absorption length of the photosensitive pixel," which in turn, increases the quantum efficiency. Haddad204, [0073], [0076]. Increasing quantum efficiency using surface features is the same goal shared by Haddad138. Haddad138, [0063]. Both Haddad138 and Haddad204

teach that “[a]ny increase in the quantum efficiency makes a large difference in the signal to noise ratio.” Haddad138, [0050], Haddad204, [0058].

298. It would also have been a use of known technique (i.e., Haddad204’s non uniform arrangement) to improve similar devices in the same way. Both Haddad138 and Haddad204 are SiOnyx’s patent applications that share the same inventor: Homayoon Haddad, Jutao Jiang, Jeffrey McKee, Drake Miller, Chintamani Palsule, and Leornard Forbes. Both Haddad138 and Haddad204 concern photodetectors with textured regions that increase quantum efficiency. Haddad138, [0063]-[0064], [0087]; Haddad204, [0073], [0053]. The textured regions in both references include similarly shaped surface features such as pillars. Haddad138, [0063]; Haddad204, [0073]. The textured regions in both references can be formed by chemical etching. Haddad138, [0006]; Haddad204, [0093].

299. A POSITA would have had a reasonable expectation of success. It would have been well within the abilities of a POSITA to use Haddad204’s non uniform arrangement of pillars for Haddad138’s arrangement of pillars, given that it would have involved routine manufacturing steps that Haddad204 had already used in its device with predictable results.

300. Therefore, Haddad138 in view of Haddad204 renders this limitation obvious.

2. Claim 55

- a) **“The device of claim 32, wherein the surface features are arranged according to a pattern that is a non-uniform arrangement.”**

301. Haddad138 in view of Haddad204 renders this limitation obvious.

302. See discussion above regarding claims 25 and 32.

F. Ground A-6: Claims 25 and 55 Are Obvious Based on Haddad138 and Park

1. Claim 25

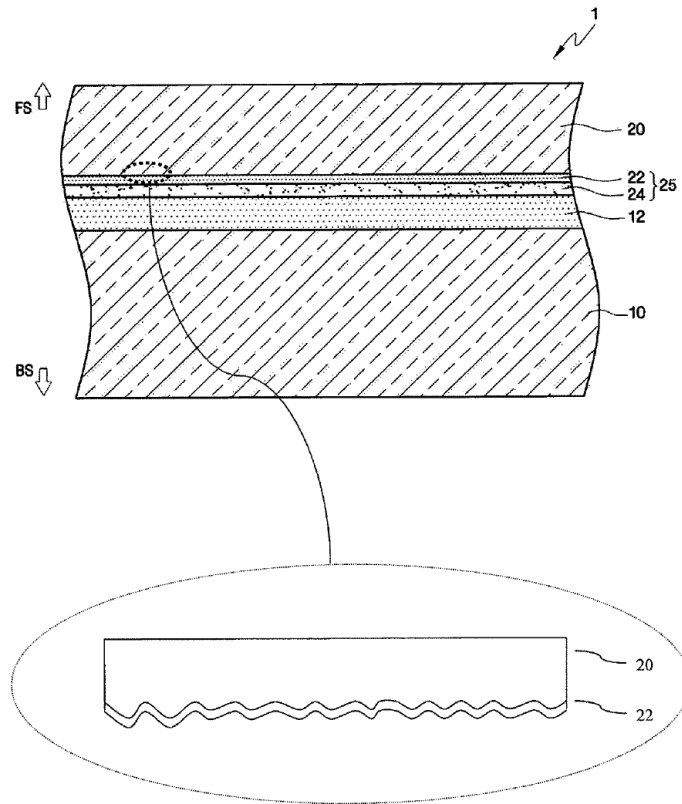
- a) **“The device of claim 1, wherein the pattern is a non-uniform arrangement.”**

303. Haddad138 in view of Park renders this limitation obvious.

304. As discussed above regarding limitation 1[b] in Ground A-1, Haddad138 discloses a photodetector with a textured region. Haddad138, [0087], [0084], [0064]. Haddad138 discloses that its textured region can include surface features such as protrusions. Haddad138, [0063].

305. Similarly, Park discloses a photodetector with a textured region including surface features with protrusions. Park, [0072] (“Referring to the inset in FIG. 1 ... reflections may also be reduced by processing the second substrate 20 to have an *uneven surface* facing the oxide layer 22.”), Fig. 8D-2(f).

FIG. 1



Park, Fig. 1. “The oxide layer 22 may have an uneven surface where it meets the second substrate 20.” Park, [0072]. “The oxide layer 22 may also have an uneven surface at the opposing surface.” Park, [0072]. As its name suggests, and as depicted in Figure 1, Park’s uneven surface has protrusions in a non-uniform arrangement.

306. It would have been obvious to use Park’s uneven surface in place of, or in addition to, Haddad138’s surface features because Park teaches that the uneven surface helps with absorbing incident light by reducing reflection. Park, [0072]. Decreasing reflection of incident light means more light entering the silicon substrate to be absorbed. Haddad138 teaches that increased absorption of incident

light increases quantum efficiency, Haddad138, [0063], and that “[a]ny increase in the quantum efficiency makes a large difference in the signal to noise ratio.” Haddad138, [0050]. Based on the teachings of Park and Haddad138, a POSITA would have been motivated to use Park’s uneven surface.

307. It would have been a use of known technique (i.e., Park’s uneven surface) to improve similar devices in the same way. Both Haddad138 and Park concern increasing quantum efficiency of photodetectors. Haddad138, [0063], [0087], [0006]; Park, [0004]-[0005], Fig. 8D-2(f). To achieve this goal, Haddad138 uses a textured region with protrusions and Park similarly uses an uneven surface with protrusions. Haddad138, [0063]; Park, [0072]. Both Haddad138 and Park disclose placing the textured region or the uneven surface on the light incident side. Haddad138, [0049] (“It should also be noted that the photosensitive diode can be configured with a BSI architecture, and thus electromagnetic radiation would enter the semiconductor substrate from the direction of the textured region”); Park, Figs. 1, 7. Like Park’s uneven surface, the Haddad138’s textured region can “enhance the absorption properties by reducing the amount of incident electromagnetic radiation that is reflected from the device.” Haddad138-Provisional434, 5.

308. A POSITA would have had a reasonable expectation of success. It would have been well within the abilities of a POSITA to use Park’s non uniform arrangement of protrusions for Haddad138’s arrangement of protrusions, given that

it would have involved routine manufacturing steps that Park had already used in its device with predictable results.

309. Therefore, Haddad138 in view of Park renders this limitation obvious.

2. Claim 55

- a) “The device of claim 32, wherein the surface features are arranged according to a pattern that is a non-uniform arrangement.”**

310. Haddad138 in view of Park renders this limitation obvious.

311. See discussion above regarding claims 25 and 32.

G. Ground B-1: Claims 26, 28-29, and 31 Are Anticipated, or at a Minimum Obvious, Based on Yap

1. Claim 26

- a) 26[pre]: “A method of making a photosensitive image device, comprising:”**

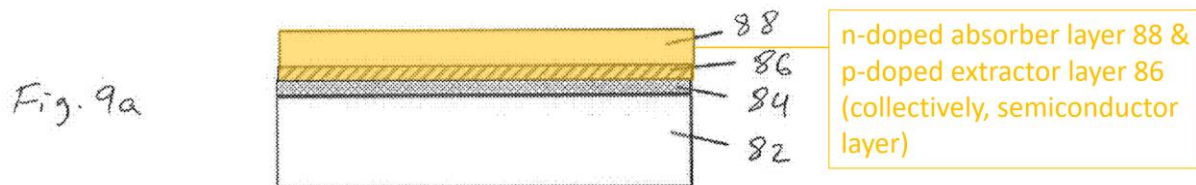
312. Yap discloses this preamble to the extent it is limiting.

313. Yap discloses that its invention “relates generally to photon detectors” (i.e., the claimed photosensitive image device). Yap, 1:19-20, Fig. 11. Yap discloses “FIGS. 9a-9l depict an exemplary fabrication process for fabricating the detector array and attaching that detector array to the read-out integrated circuit.” Yap, 7:35-37.

- b) 26[a]: “providing a semiconductor layer having a light incident side and an opposed side, said semiconductor layer having multiple doped regions forming at least one junction;”**

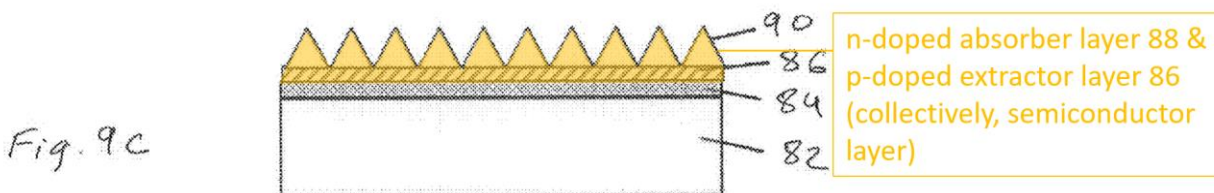
314. Yap discloses this limitation.

315. Figure 9a depicts an n-doped absorber layer 88 and a p-doped extractor layer 86 (i.e., collectively, the claimed semiconductor layer having multiple doped regions forming at least one junction). Yap, 7:45-51; *see also* Yap, 1:40-42 (“Photovoltaic detectors typically contain P-type semiconductor material, N-type semiconductor material and a PN junction.”).



Yap, Fig. 9a (annotated).

316. Yap discloses etching the n-doped absorber layer 88 into pyramid shapes 90. Yap, 8:25-27.

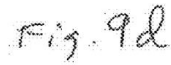


Yap, Fig. 9c (annotated).

317. The top side of the semiconductor layer with the pyramid shapes in the claimed light incident side. Yap, 4:41-43. The bottom side corresponds to the claimed opposed side.

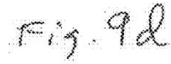
318. Therefore, Yap discloses this limitation.

320. Yap discloses providing a carrier substrate 96 (i.e., the claimed support
ate) for bonding with the semiconductor layer. Yap, 8:49-51.



d) 26[c]: “bonding the semiconductor layer to the support substrate;”

322. Yap discloses bonding the semiconductor layer to the carrier substrate 96 (the claimed support substrate). Yap, 8:49-51.

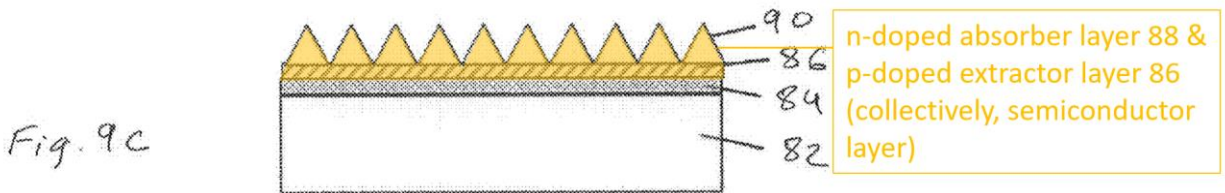


SAMSUNG EX. 1004 - 106/114

- e) **26[d]: “creating a plurality of surface features on one of the semiconductor layer and the support substrate, wherein the surface features are formed via etching;”**

323. Yap discloses this limitation. Claim 26 allows limitations 26[d]-[f] to be performed before limitation 26[c] because it does not require those limitations to be performed after limitation 26[c].

324. Yap discloses etching the n-doped absorber layer 88 into pyramid shapes 90 (i.e., the claimed surface features). Yap, 8:25-27.

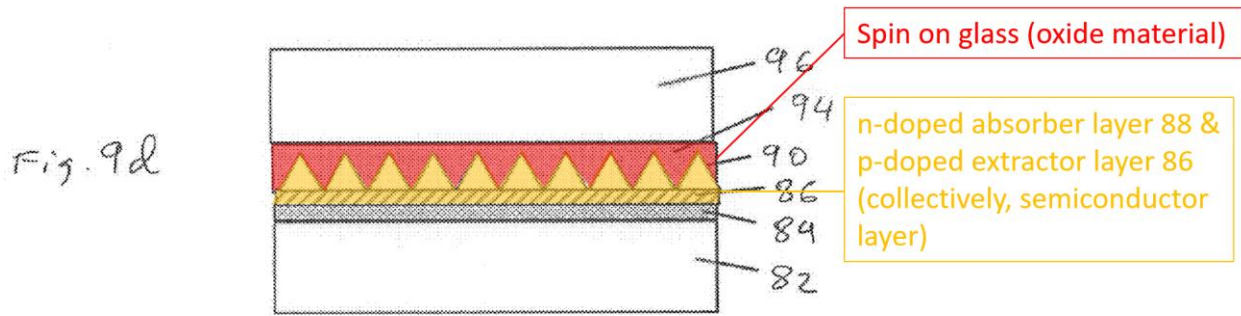


Yap, Fig. 9c (annotated).

- f) **26[e]: “depositing an oxide material within at least a portion of the semiconductor layer or support substrate removed during etching; and”**

325. Yap discloses this limitation.

326. Yap discloses “a material 94 is deposited in the spaces between the pyramids 90.” Yap, 8:44-45. Yap further discloses that the material 94 can be spin on glass, Yap, 8:45-47, which is an oxide material.



Yap, Figs. 9d (annotated).

- g) **26[f]: “processing the region of the semiconductor layer or support substrate comprising the surface features with CMP after depositing the oxide material.”**

327. Yap discloses this limitation under Patent Owner’s proposed construction in the Related Case.

328. In the Related Case, I understand that Petitioner proposed that this term is indefinite because of missing antecedent basis. Ex-1013, 5. I understand that Patent Owner proposed that the term has a plain and ordinary meaning and that, to the extent a construction is required, it means “a polishing step or series of polishing steps in the fabrication of the imager device performed after the deposition of the oxide material.” Ex-1014, 4.

329. Yap discloses that, after being deposited, “[t]he material 94 may then be planarized,” i.e., processed with CMP, as required by this limitation, or polished, as required by Patent Owner’s proposed construction in the Related Case. Yap, 8:47.

330. Therefore, Yap discloses this limitation under Patent Owner's proposed construction in the Related Case.

2. Claim 28

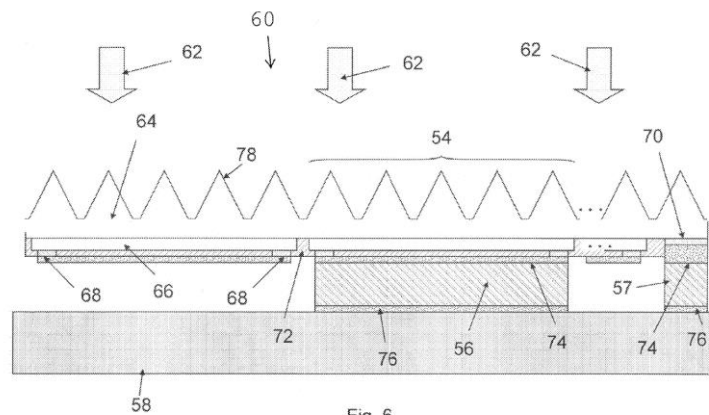
- a) **“The method of claim 26, wherein the plurality of surface features are formed on the light incident side of the semiconductor layer.”**

331. Yap discloses this limitation.

332. See discussion above regarding limitation 26[a].

333. Figure 6 also depicts pyramids 78 formed on the side of the incident light

62. Yap, 6:22-25.



Yap, Fig. 6.

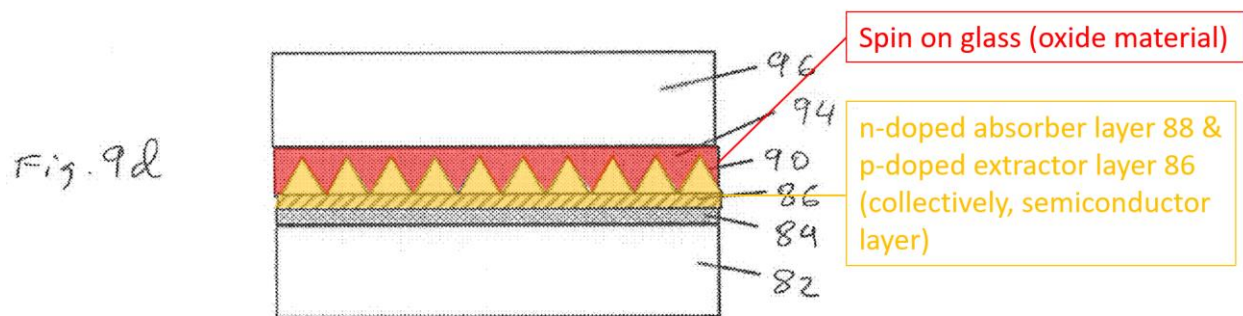
334. Therefore, Yap discloses this limitation.

3. Claim 29

- a) **“The method of claim 26, wherein depositing the oxide material comprises at least partially filling one of trenches, holes, pits, and cones formed in the semiconductor layer during etching.”**

335. Yap discloses this limitation.

336. Yap discloses “a material 94 is deposited in the spaces between the pyramids 90.” Yap, 8:44-45. Yap further discloses that the material 94 can be spin on glass, Yap, 8:45-47, which is an oxide material.



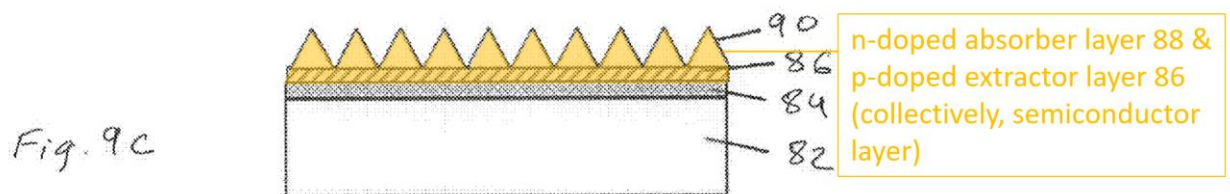
Yap, Figs. 9d (annotated).

4. Claim 31

a) **“The method of claim 26, wherein the surface features are formed in the semiconductor layer.”**

337. Yap discloses this limitation.

338. As discussed above regarding limitation 26[a], Yap discloses etching the n-doped absorber layer 88 into pyramid shapes 90. Yap, 8:25-27.



Yap, Fig. 9c (annotated).

H. Ground B-2: Claim 27 Is Obvious Based on Yap and Alie

1. Claim 27

1. 27[pre]: “The method of claim 26, wherein bonding the semiconductor layer to the support substrate comprises:”

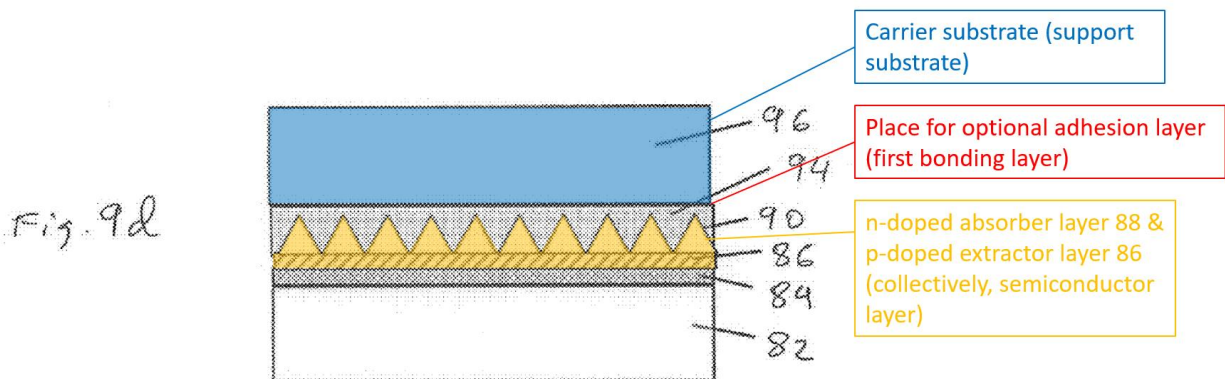
339. Yap discloses this preamble to the extent it is limiting.

340. See the discussion above regarding claim 26 in Ground B-1.

2. 27[a]: “depositing a first bonding layer onto the semiconductor layer; and”

341. Yap discloses this limitation.

342. Yap discloses depositing an optional adhesion layer (i.e., the claimed first bonding layer) on to the semiconductor layer. Yap, 8:48-49.



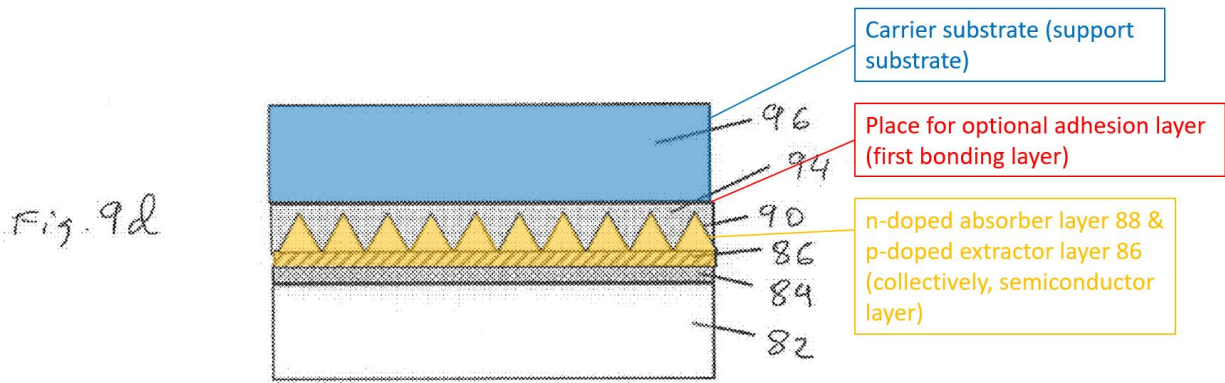
Yap, Fig. 9d (annotated).

3. 27[b]: “bonding the first bonding layer to a second bonding layer disposed on the support substrate.”

343. Yap in view of Alie renders this limitation obvious.

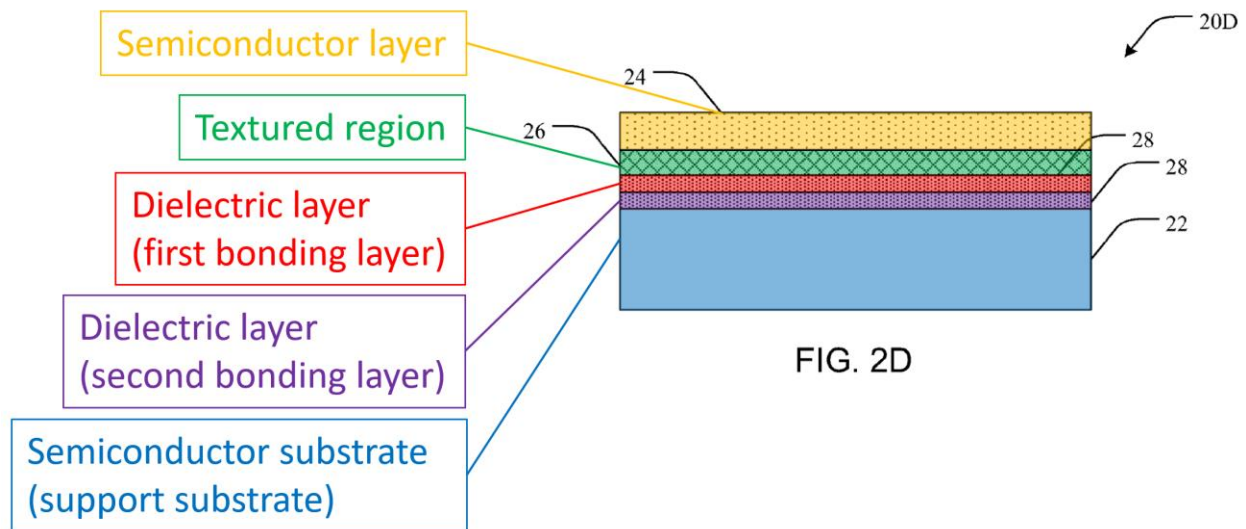
344. Yap discloses bonding the first bonding layer to the support substrate.

Yap, 8:49-52.



Yap, Fig. 9d (annotated).

345. Alie discloses using a dielectric layer as a bonding layer in a photodetector. Alie, [0055]. Alie further discloses that, instead of using just one dielectric layer for bonding, two dielectric layers can be used. Alie, [0059]. “In the case of wafer bonding, for example, a first dielectric layer can be associated with the textured layer and a second dielectric layer can be associated with the semiconductor substrate.” Alie, [0059]. “The first dielectric layer and the second dielectric layer are heated and pressed together, with or without the aid of further pressure, temperature, or plasma surface activation, to cause the dielectric layers to bond to one another, thus forming a single wafer-bonded structure.” Alie, [0059]. Figure 2D depicts the use of the second bonding layer positioned between the first bonding layer and the support substrate:



Alie, Fig. 2D (annotated).

346. It would have been obvious to combine Yap with Alie. It would also have been a use of known technique (i.e., Alie's bonding layers) to improve similar devices in the same way. Both Yap and Alie concern photodetectors with textured regions that increase quantum efficiency. Yap, 4:39-47, Fig. 11; Alie, [0052], [0096], [0006]. The textured regions in both references include similarly shaped surface features. Yap, 4:39-40 ("Each detector pixel comprises a pyramidal structure"); Alie, [0068] ("Non-limiting examples of shapes and configurations of surface features include ... pyramids"). The textured regions in both references can be formed by chemical etching. Yap, 8:29-32; Alie, [0074].

347. A POSITA would have had a reasonable expectation of success. It would have been well within the abilities of a POSITA to use Alie's bonding layers for Yap's

device, given that it would have involved routine manufacturing steps that Alie had already used in its device with predictable results.

IX. EVIDENCE OF NON-OBVIOUSNESS

348. It is my understanding that in order for evidence of non-obviousness to be relevant, there must be a nexus between the claimed invention and the evidence. I am not aware of any evidence of non-obviousness. I reserve the right to respond to any purported objective evidence of non-obviousness raised by Patent Owner.

X. CONCLUSION

349. I declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

Tuesday, September 24, 2024



Michael Lebby