

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

REOLINK DIGITAL TECHNOLOGY CO., LTD.
Petitioner,

v.

KT IMAGING US, LLC
Patent Owner

U.S. Patent No. 8,004,602

**DECLARATION OF R. JACOB BAKER, PH.D., P.E.,
IN SUPPORT OF PETITION FOR *INTER PARTES* REVIEW
OF U.S. PATENT NO. 8,004,602**

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I, R. Jacob Baker Ph.D., P.E., declare as follows:

I. INTRODUCTION

1. I have been retained by Samsung Electronics Co., Ltd. (“Petitioner”) as an independent expert consultant in this proceeding before the United States Patent and Trademark Office (“PTO”) regarding U.S. Patent No. 8,004,602 (“the ’602 patent”) (Ex. 1001).

2. My name is R. Jacob Baker and I am a Professor of Electrical and Computer Engineering at the University of Nevada, Las Vegas. I have prepared this declaration as an expert witness on behalf of Petitioner Reolink Digital Technology Co., Ltd. (“Petitioner” or “Reolink Digital”). In this declaration, I will give my opinion as to whether claims 1–15 of the ’602 patent are unpatentable. I also provide herein the technical bases for these opinions, as appropriate.

3. For my efforts in connection with the preparation of this declaration, I have been compensated at my usual and customary rate for this type of consulting activity. My compensation is in no way contingent on the outcome of these or any other proceedings.

4. I have been asked to consider whether certain references disclose or suggest the features recited in claims 1–15 of the ’602 patent. My opinions are set forth below.

II. QUALIFICATIONS / PROFESSIONAL BACKGROUND

5. I presently serve as a Professor of Electrical and Computer Engineering at the University of Nevada, Las Vegas (UNLV). All of my opinions stated in this declaration are based on my own personal knowledge and professional judgment. In forming my opinions, I have relied on my knowledge and experience in designing, developing, researching, and teaching regarding semiconductors, semiconductor packaging, and semiconductor image sensors.

6. I am over 18 years of age and, if I am called upon to do so, I would be competent to testify as to the matters set forth herein. I understand that a copy of my current curriculum vitae, which details my education and professional and academic experience, is being submitted by Petitioner as Exhibit 1003. The following provides an overview of some of my experience that is relevant to the matters set forth in this declaration.

7. I have been teaching electrical engineering at UNLV since 2012. Prior to that position, I was a Professor of Electrical and Computer Engineering at Boise State University from 2000. Prior to my position at Boise State University, I was an Associate Professor of Electrical Engineering between 1998 and 2000 and Assistant Professor of Electrical Engineering between 1993 and 1998 at the University of

Idaho. I have been teaching electrical engineering since 1991. I have been working as an engineer since 1985.

8. I received B.S. and M.S. degrees in Electrical Engineering from UNLV in 1986 and 1988, respectively. I received my Ph.D. in Electrical Engineering from the University of Nevada, Reno in 1993.

9. As described in my CV, I am a licensed Professional Engineer and have more than 35 years of industry and academic experience, including extensive experience in circuit design, fabrication, and manufacture of Dynamic Random Access Memory (DRAM) semiconductor integrated circuit chips, Phase-Change Random Access Memory (PCRAM) chips, and CMOS Image Sensors (CISs) at Micron Technology, Inc. ("MTI") in Boise, Idaho.

10. I have extensive experience in the development of instrumentation and commercial products in a multitude of areas including: integrated electrical/biological circuits and systems, array (memory, imagers, and displays) circuit design, CMOS analog and digital circuit design, diagnostic electrical and electro-optic instrumentation for scientific research, CAD tool development and online tutorials, low-power interconnect and packaging techniques, and power electronics. For example, a part of my research at Boise State, for many years, focused on the use of Thru-Silicon-Vias (TSVs), aka Thru-Wafer Vias (TWVs), for

high-density packaging. These packaging techniques were utilized in the memory module development work I did with Sun Microsystems and Oracle.

11. I have been recognized for my contributions as an educator in the field. While at Boise State University, I received the President's Research and Scholarship Award (2005), Honored Faculty Member recognition (2003), and Outstanding Department of Electrical Engineering Faculty recognition (2001). In 2007, I received the Frederick Emmons Terman Award (the "Father of Silicon Valley"). The Terman Award is bestowed annually upon an outstanding young electrical/computer engineering educator in recognition of the educator's contributions to the profession. In 2011, I received the IEEE Circuits and Systems Education Award. I received the Tau Beta Pi Outstanding Electrical and Computer Engineering Professor Award every year it was awarded while I have been back at UNLV.

12. I am the author of several books covering the area of integrated circuit design including: DRAM Circuit Design: Fundamental and High-Speed Topics (two editions), CMOS Circuit Design, Layout, and Simulation (four editions), and CMOS Mixed-Signal Circuit Design (two editions). I have authored, and coauthored, more than 100 papers and presentations in the areas of solid-state circuit design, fabrication, and packaging. I am the named inventor on 152 granted U.S. patents in

integrated circuit designs. I have performed technical and expert witness consulting for more than 200 companies and their subsidiaries and given more than 50 invited talks at conferences, companies, and universities.

13. I currently serve, or have served, as a volunteer on the IEEE Press Editorial Board (1999-2004); as editor for the Wiley-IEEE Press Book Series on Microelectronic Systems (2010-2018); as the Technical Program Chair of the 2015 IEEE 58th International Midwest Symposium on Circuits and Systems (MWSCAS 2015); on the IEEE Solid-State Circuits Society (SSCS) Administrative Committee (2011-2016); as a Distinguished Lecturer for the SSCS (2012-2015); the Technology Editor (2012-2014) and Editor-in-Chief (2015-2020) for IEEE Solid-State Circuits Magazine; IEEE Kirchhoff Award Committee (2020-2023); and advisor for the student branch of the IEEE at UNLV (2013-2024). These meetings, groups, and publications are intended to allow researchers to share and coordinate research. My active participation in these meetings, groups, and publications allowed me to see what other researchers in the field have been doing.

III. MATERIALS REVIEWED

14. The opinions contained in this Declaration are based on the documents I reviewed, my professional judgment, as well as my education, experience, and

knowledge regarding electrical engineering, circuit design, and electrical devices, such as semiconductor image sensor substrates and packages.

15. In forming my opinions expressed in this Declaration, I reviewed the following materials and information:

EXHIBIT	DESCRIPTION
Ex. 1001	U.S. Patent No. 8,004,602
Ex. 1003	Curriculum Vitae of R. Jacob Baker, Ph.D., P.E.
Ex. 1004	File History of U.S. Patent No. 8,004,602
Ex. 1005	U.S. Patent Application Publication No. 2004/0245649 (“Imaoka”)
Ex. 1006	U.S. Patent Application Publication No. 2006/0028573 (“Seo”)
Ex. 1007	U.S. Patent Application Publication No. 2005/0077458 (“Ma”)
Ex. 1008	U.S. Patent Application Publication No. 2006/0035415 (Wood”)
Ex. 1009	U.S. Patent Application Publication No. 2008/0284041 (“Jang”)
Ex. 1010	U.S. Patent Application Publication No. 2007/0181792 (“Yoshimoto”)
Ex. 1011	U.S. Patent Application Publication No. 2007/0145420 (“Okada”)

16. I also reviewed any other materials I refer to in this Declaration in support of my opinions.

17. My opinions contained in this declaration are based on the documents I reviewed and my knowledge and professional judgment. My opinions have also been guided by my appreciation of how a person of ordinary skill in the art

(POSITA) would have understood the state of the art, the prior art, and the claims and the specification of the '602 patent at the time of the alleged invention. I have been asked to initially consider that the time of the alleged invention of the '602 patent is around May 16, 2008. My opinions reflect how one of ordinary skill in the art (which I have described below) would have understood the '602 patent, the prior art to the patent, and the state of the art at the time of the alleged invention.

18. Based on my experience and expertise, it is my opinion that the prior art discloses and/or suggests all the features recited in challenged claims 1–15 of the '602 patent, as I discuss in detail below.

19. All of my opinions in this declaration are from the perspective of one of ordinary skill in the art, during the relevant timeframe (*e.g.*, the time of the alleged invention), which I have been asked to assume is around May 16, 2008.

IV. LEVEL OF ORDINARY SKILL IN THE ART

20. In determining the skills of a hypothetical POSITA of the '602 patent at the time of the claimed invention (which I have been asked to assume is May 2008), I considered several things, including various prior art techniques for integrating lens modules with image sensor chips, chip-scale packages, through-wafer vias, and redistribution wirings. I also considered the type of problems that such techniques gave rise to and the rapidity with which innovations were made. I

also considered the sophistication of the technologies involved and the educational background and experience of those actively working in the field.

21. For the purposes of my analysis, I have been asked to assume that a POSITA in the field of art of the '602 patent would have had (1) a Master of Science degree in engineering, with approximately two years of experience with semiconductor or image sensor packaging; or (2) a Bachelor of Science degree in engineering with approximately four years of experience with semiconductor or image sensor packaging. My opinions below have taken that into account and reflect that level of skill in determining the content of the prior art and what it would have suggested to a POSITA.

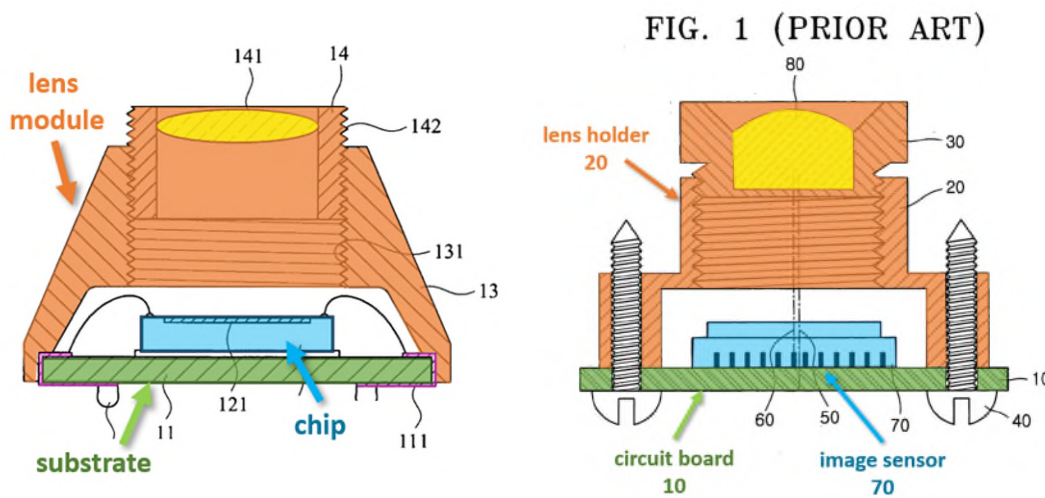
IV. BACKGROUND OF THE TECHNOLOGY

22. By the time of the alleged invention, digital imaging technology was well established and used in an increasing variety of applications, such as miniature fixed-focus digital camera modules incorporated in portable telephones and personal digital assistants (PDAs). (Ex. 1007, ¶0002.) There was a known desire for fabricators to reduce the size and cost of the image sensor modules, as well as simplify design for incorporation into the end products. (*Id.*)

23. Image sensor modules typically included an image sensor that receives an image and converts the light signal into an electrical signal. (Ex. 1007, ¶0003.)

Some level of image processing of the electrical signal could be accomplished using circuitry incorporated into the image sensor module before being output the external circuitry. Electrical contacts typically would provide connectivity between the image sensor modules and the end products incorporating the modules. (*Id.*)

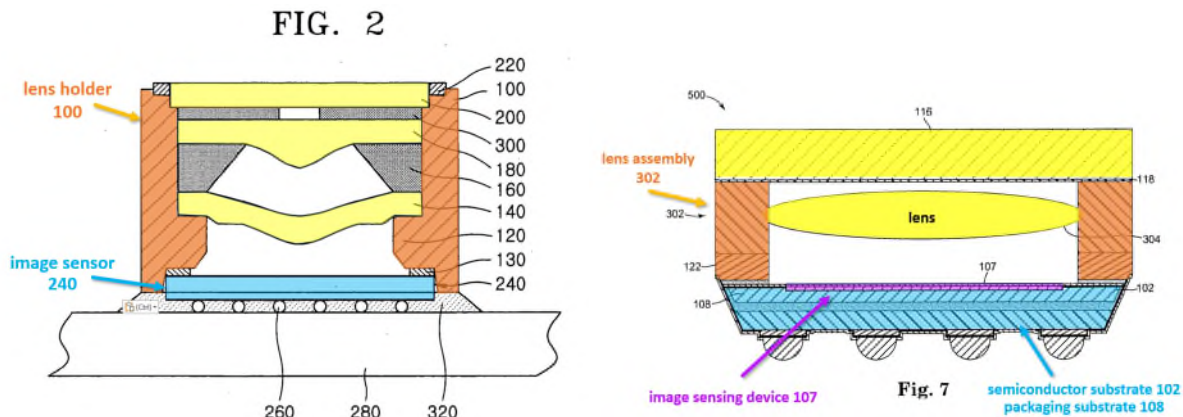
24. One known implementation of image sensor modules was as a camera modules—complete miniature camera assemblies for incorporation into end products. (Ex. 1007, ¶0004.) A camera module generally included an image sensor, as well as a lens for focusing incoming light onto the image sensor. (*Id.*) A conventional camera module also typically included a chassis and/or enclosure for mounting the image sensor chip and optical components and for protecting the components from particulate and spurious light contamination. (*Id.*) A conventional chassis/enclosure included a focusing adjustment mechanism for aligning the lens and image sensor during fabrication. (*Id.*; *see also* Ex. 1001, FIG. 1; Ex. 1006, FIG. 1.) A couple depictions of conventional camera modules are provided below.



(Ex. 1001, FIG. 1 (illustrating prior art); Ex. 1006, FIG. 1 (same)).

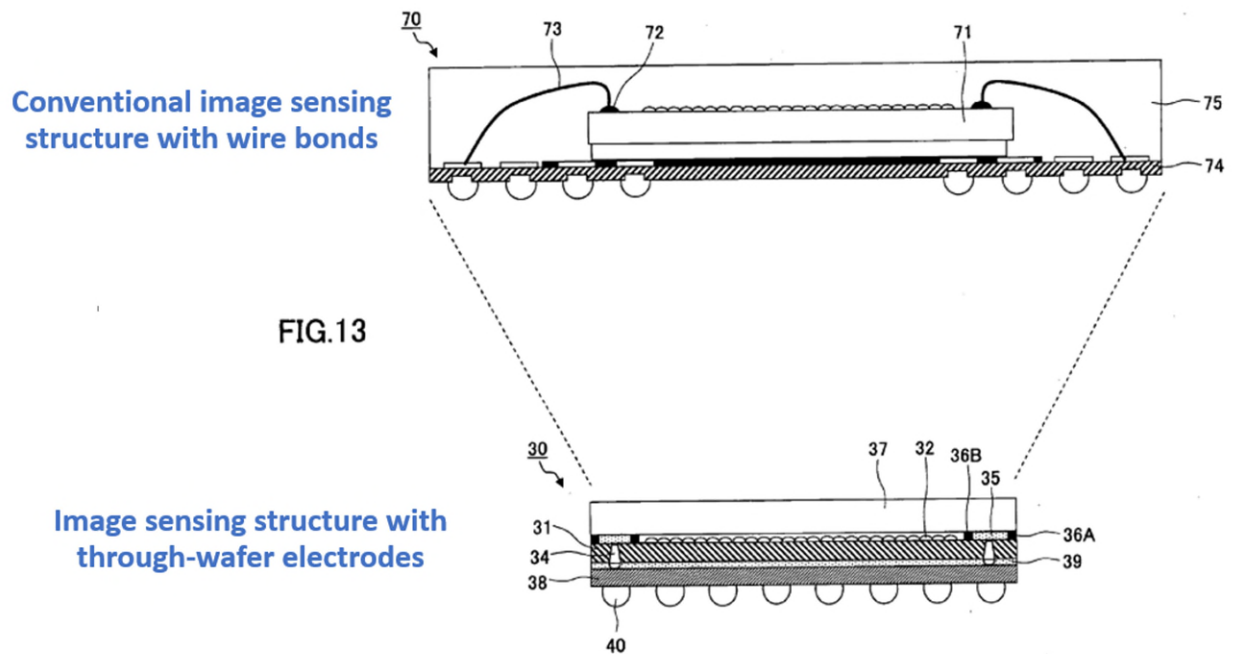
25. The focusing adjustment mechanism were commonly in the form of mating pieces, as part of the main chassis/enclosure, and lens assembly piece. (Ex. 1007, ¶0004.) During fabrication, the mating pieces are aligned so that the lens directs an image onto the image sensor. (*Id.*) This assembly step is typically performed on each individual camera module fabricated. (*Id.*) Therefore, the assembly step is time consuming and labor-intensive, and therefore costly. (*Id.*)

26. In light of these well understood drawbacks, a particularly notable solution in the prior art was to combine the lens assembly directly with the image sensor and thereby fix the alignment and distance between the lens of the image sensor. As discussed in further detail in the Grounds below, Seo and Ma both illustrate such a known solution. (See, *e.g.*, Ex. 1006, ¶¶0005–0009.)



(Ex. 1006, FIG. 2; Ex. 1007, FIG. 7.)

27. In addition to the needs discussed above, at the time of the alleged invention, there was also an increasing desire in the art to reduce the size of image sensor camera modules, in particular, for integration within mobile phones, laptop computers, and similar devices. (See, e.g., Ex. 1005, ¶¶0004; Ex. 1008, ¶¶0004–0015, 0045, FIG. 2; Ex. 1009, ¶¶0005–0013, 0094–0101, FIG. 14; Ex. 1010, ¶¶0053–0054, 0088–0092, FIGs. 5, 13.) But this too had known solutions. (*Id.*) One technique was to use through-wafer or through-silicon vias instead of bulkier solutions. The comparison below, for example, illustrates the comparative size reduction for image sensor packages using through-wafer vias as compared to those using a wire bond technique.



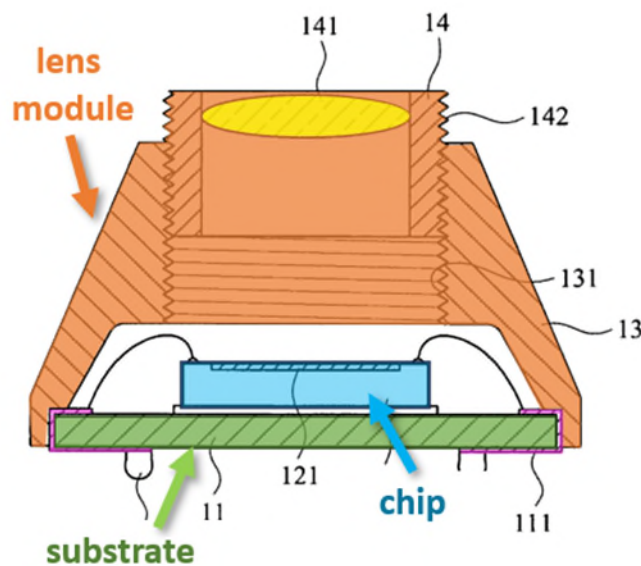
(Ex. 1010, FIG. 13.)

28. In sum, before the '602 patent, camera modules were known to: (i) combine image sensor chips with lens modules, which had the benefits of, for example, obviating the need for focus adjustment and simplifying the fabrication of the module; and (ii) well-known through-wafer-via techniques allowed electrical connections of electrodes through the image sensor chips, which had the benefit of, for example, alleviating some of the size constraints imposed by other wiring arrangements. (*See also* my discussion in Grounds I and II below). Thus, as discussed below, the purported problems and solutions, as identified by the '602 patent had actually been solved using similar techniques before the time of the alleged invention.

V. OVERVIEW OF THE '602 PATENT

29. The '602 patent is directed to an image sensor structure and an integrated lens module for “digital image products,” such as digital cameras, camera phones, video phones, fingerprint readers and so on. (Ex. 1001, 1:7–18.) The '602 patent purports to simplify the manufacturing process and lower costs compared to the “conventional” image sensor arrangements. (*Id.* at 1:18–2:45.)

30. The '602 patent illustrates a “conventional” image sensor structure, where “chip 12 is settled on the substrate 11 and includes a light-sensing element 121 thereon.” (Ex. 1001, 1:23–30, FIG 1 (below).)

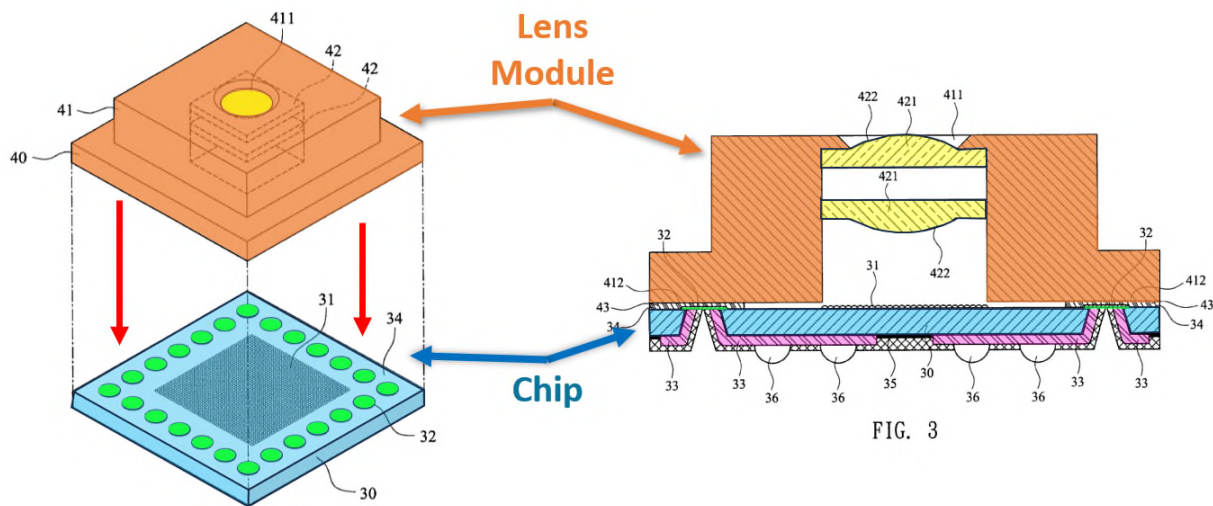


(Ex. 1001, FIG. 1.)¹

¹ All color annotations throughout are added unless noted otherwise.

31. According to the '602 patent, this “conventional” arrangement undesirably requires the relative distance between lens and chip to be set to set the proper focal distance. (Ex. 1001, 1:35–59.) The complexity of this process can reduce yields and increase manufacturing costs. (Ex. 1001, 1:60–65.) In addition, the use of wire bonding to electrically connect the chip to wiring 111 on the substrate limits the minimum overall package size. (Ex. 1001, 1:42–48, 1:65–2:3.)

32. To address these drawbacks, the '602 patent, proposes (1) “implementing the chip having conducting channels, which can be electrically connected to an external circuit without the means of wire-bonding” and (2) using the integrated lens module to assemble the image sensor structure” thereby simplifying the procedure to set the relative distance between the lens and the chip. (Ex. 1001, 2:7–20.) To achieve these ends, the '602 patent describes designing an image sensor structure to include two main features: (1) a conducting channel passing through the chip; and (2) combining a bottom contact surface of a lens holder with the same surface of the chip on which the light-sensing elements are arranged. (Ex. 1001, 2:21–45; *see also id.* at 3:53–59 (“The holder 41 has a contact surface 412 on a bottom thereof for being combined with the first surface 34 of the chip 30 so that the lens module 40 can be *directly combined* with the first surface of the chip 30....”), FIG. 3.)



(Ex. 1001, FIG. 2, 3.)

33. But as discussed in my background section above, both of those features recited in the claims of the '602 were well known in the art by the time of the alleged invention. In particular, using a conducting channel passing through the chip to connect to electrodes was simply the implementation of a well-known Thru-Silicon-Vias (TSV) technique (also referred to as Thru-Wafer-Vias (TWV) and similar names) to an image sensor chip—an application well described in the prior art. (See my technology background discussion.) Further, combining a lens module directly with the image sensor chip was also well known and described in the prior art. (*Id.*) Thus, as discussed in more detail below, the same two techniques (presented as novel in the '602 patent) had in fact already been disclosed and implemented in the art with the expectation that the camera module would benefit

from well-known advantages, such as minimizing the overall size of the module and simplifying lens alignment procedures. (*Id.*)

VI. CLAIM CONSTRUCTION

34. I understand that claim terms are typically given their ordinary and customary meanings, as would have been understood by a POSITA at the time of the alleged invention, which as I explained above I have been asked to assume is around May 16, 2008. In considering the meaning of the claims, however, I understand that one must consider the language of the claims, the specification, and the prosecution history of record. I have been asked to consider the claim terms under their plain meanings and thus considered the claims, specification and prosecution history for the '602 patent in doing so in support of my opinions concerning the '602 patent and the prior art discussed herein.

35. I understand that a court adopted KTI's proposed construction of the term "chip" to mean "an integrated circuit (e.g., light sensing elements and associated circuitry) and associated electrical connections (e.g., conducting pads, conducting channels, etc.)." And I understand that the court agreed with KTI's assertion that "chip" may include a printed circuit board (PCB)—and that it is not required to exclude a PCB from the structure of a "chip" nor limited to being "formed on a flat piece of semiconductor material" in the context of the '602 patent.

36. I have been informed that, regarding the phrase, “a plurality of first conducting pads arranged around the light sensing area,” the court ruled that the phrase should be interpreted according to its plain-and-ordinary meaning and that the dictionary definitions, “on all sides of” and “in such a position as to encircle or surround,” were overly restrictive.

37. As I understand it, no other terms of the '602 patent were construed.

VII. THE PRIOR ART DISCLOSES AND/OR SUGGESTS THE RECITED FEATURES OF CLAIMS 1–15 OF THE '602 PATENT

A. Ground I – Imaoka in view of Seo discloses and/or suggests the Features of Claims 1–15

1. Claim 1

38. The combined teachings of Imaoka and Seo discloses and/or suggests all the limitations of claim 1 of the '602 patent as a whole.

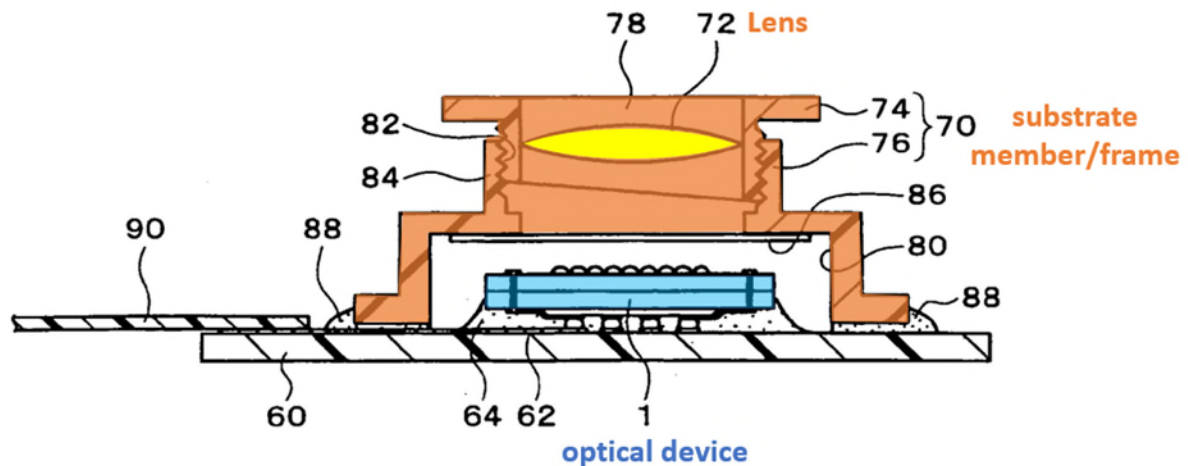
a. An image sensor structure with an integrated lens module:

39. I have been asked to assume the preamble of claim 1 is limiting for the purposes of my analysis. If the preamble is not limiting, it would not change my analysis for the limitations below.

40. Imaoka discloses an optical module in the form of an image sensor module (*i.e.*, an image sensor structure). (*See, e.g.*, Ex. 1005, ¶¶0066–0073, FIG. 4 (reproduced below).) Imaoka's optical module includes an optical device 1, a wiring

substrate 60, and a substrate member 70 (*i.e.*, an integrated lens module) holding a lens 72. (*Id.*) As illustrated in Figure 4 (below), substrate member may include a first part 74 and a second part 76 with the lens 72 attached to the first part 74 and **fixed inside** the first through hole 78. (*Id.*) Imaoka also discloses that the substrate member 70 can be a plurality of members that are mutually separable “or may be **integrally constructed** with one member.” (Ex. 1005, ¶0068.)

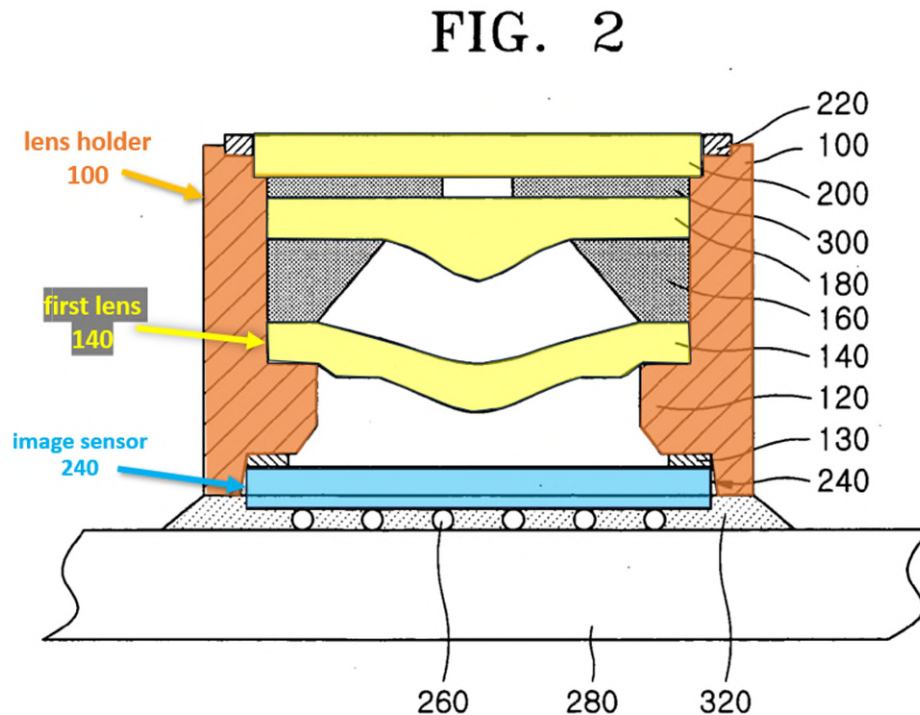
FIG.4



(Ex. 1005, FIG. 4.)

41. Seo, similar to Imaoka, also discloses an image sensor camera module (*i.e.*, an image sensor structure) with integrated lens holder (*i.e.*, an integrated lens module). (*See, e.g.*, Ex. 1006, ¶¶0012, 0018, 0022–0027, FIG. 2.) For example, as illustrated in Seo’s Figure 2, Seo’s image sensor camera module integrated with a lens holder 100 and at least one lens (*e.g.*, first lens 140 or second lens 180) which is securely adhered to the shoulder 120 inside the lens holder 100, and the image

sensor camera module is mounted to an image sensor 240. *Id.* Figure 2 (below) “is a cross-sectional view of an image sensor camera module.” (Ex. 1006, ¶¶0018, 0022–0033.)



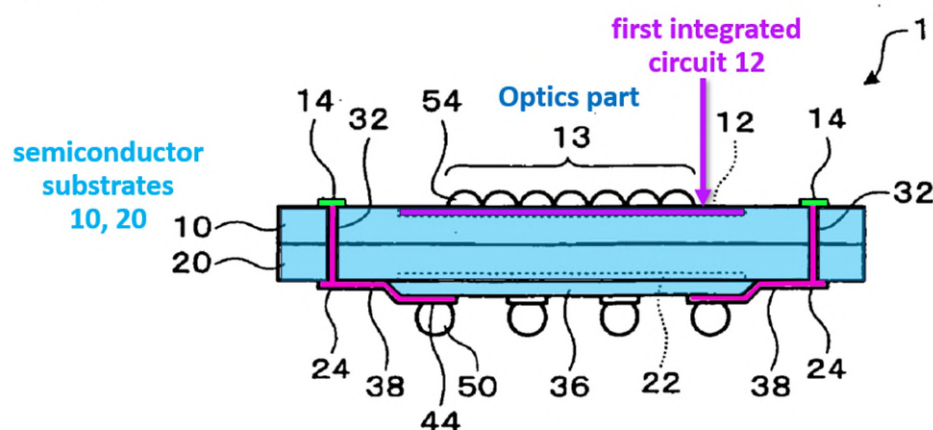
(Ex. 1006, FIG. 2.)

42. Additionally, the Imaoka-Seo combination suggests an image sensor structure with an integrated lens module as a straightforward combination of known components according to their known functions and resulting in a predictable structure, as further discussed below. Additionally, the Imaoka-Seo combination discloses or suggests each of the remaining features of claims 1–15 for the reasons presented in Section VII.A.

- b. a chip having a plurality of light-sensing elements arranged on a light-sensing area of a first surface of the chip

43. Imaoka discloses this limitation. For example, Imaoka discloses a first semiconductor substrate 10 “**may be a semiconductor chip** (for example, **a silicon chip**).” (Ex. 1005, ¶¶0050, 0052, FIG. 1.) Imaoka also states that semiconductor substrate 10 includes integrated circuit 12 (which may include, *e.g.*, light-sensing elements and associated circuitry) and associated electrical connections (*e.g.*, first pads 14, conducting parts 38, *etc.*). (*Id.*) In addition, semiconductor substrate 20 may contain integrated circuit 22 and second pads 24 and stacked and bonded together with semiconductor substrate 10. (Ex. 1005, ¶¶0050–0061.) This stacking and bonding of the semiconductor substrates occurs at the wafer level and thus, a POSITA would have understood Imaoka’s optical device 1 would constitute a “chip.”

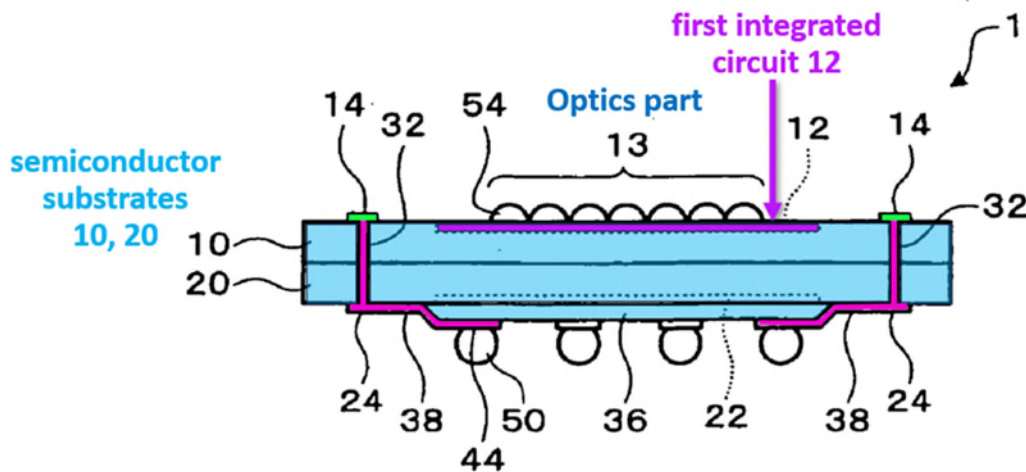
FIG.1



(Ex. 1005, FIG. 1.)

44. Further, Imaoka's optical device 1 also satisfies the court's broader construction of "chip," namely, "an integrated circuit (e.g., light sensing elements and associated circuitry) and associated electrical connections (e.g., conducting pads, conducting channels, etc.)" at least because of the inclusion of integrated circuits 12, 22, and associated electrical connections, such as first pads 14 and conducting parts 38.

45. Imaoka also discloses the other aspects of limitation 1(b), namely the chip having a plurality of light-sensing elements arranged on a light-sensing area of a first surface of the chip. For example, Figure 1 (below) shows optical device 1 has a first integrated circuit 12 and an optical part 13 made of light receiving elements which are formed on a surface of the first semiconductor 10. (Ex. 1005, FIG. 1.) Imaoka also describes these features. (*See, e.g.*, Ex. 1005, ¶0050 ("If the first semiconductor substrate 10 forms a rectangular parallelepiped, the first **integrated circuit 12 is formed on either one of the surfaces (widest face) of the first semiconductor substrate.**"), ¶0052 ("In this embodiment, the first semiconductor substrate 10 has an optical part 13. **The optical part 13 is a part to which light enters or from which light is emitted.**")



(Ex. 1005, FIG. 1.)

46. Imaoka further discloses that integrated circuit 12 and optical part 13 may include “[a] plurality of light-receiving elements.” (i.e., a plurality of light-sensing elements). (See, e.g., Ex. 1005, ¶0052.) In particular, Imaoka states:

The optical part 13 converts optical energy and other energies (for example, electrical energy). Namely, the optical part 13 has at least one energy converter (not illustrated). The energy converter (a light-receiving element and a light emitting device)... is a part of the first integrated circuit 12. In this embodiment, the energy converter is the light-receiving element (for example, a photodiode). (Ex. 1005, ¶0052.)

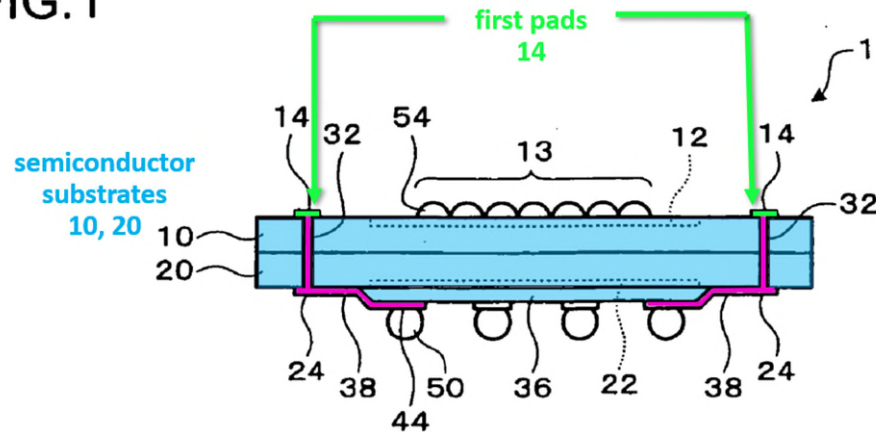
47. Imaoka explains that the light-receiving elements are arranged so as to “enable image sensing by corresponding to each of a plurality of pixels two-dimensionally arrayed.” (Ex. 1005, ¶0052.) Hence, Imaoka teaches a optical part 13 of optical device 1 having a plurality of light-sensing elements (e.g., photodiodes)

arranged on a light-sensing area of a first surface of the optical device (and semiconductor substrate 10 in particular).

c. a plurality of first conducting pads arranged around the light-sensing area and electrically connected to the light-sensing elements

48. Imaoka discloses this limitation. For instance, Imaoka discloses first pads 14 (*i.e.*, a plurality of conducting pads) surrounding (*i.e.*, arranged around) the first integrated circuit 12 and optical part 13 (*i.e.*, the light-sensing area) and electrically connected to the light-receiving elements/photodiodes (*i.e.*, the light-sensing elements). Ex. 1005, ¶0050 (“At least one of the **plurality of first pads 14 is electrically connected to the first [integrated] circuit [12]**. ... The plurality of first pads 14 may be arrayed at an end (along at least one side (for example, ... four opposite sides) of the semiconductor substrate 10 (for example, a semiconductor chip). **The plurality of first pads 14 may be arrayed in a manner of surrounding the first integrated circuit 12.**”), 0052 (“The **energy converter (a light-receiving element and a light emitting device) is a part of the first integrated circuit 12**. In this embodiment, the energy converter is the light-receiving element (for example, a photodiode).”), 0057, FIG. 1.). In this regard, Imaoka’s description of an image sensor chip is consistent with a conventional arrangement of conducting pads which output the signal from the photosensitive elements to be connected to external circuitry, such as wiring substrate 60.

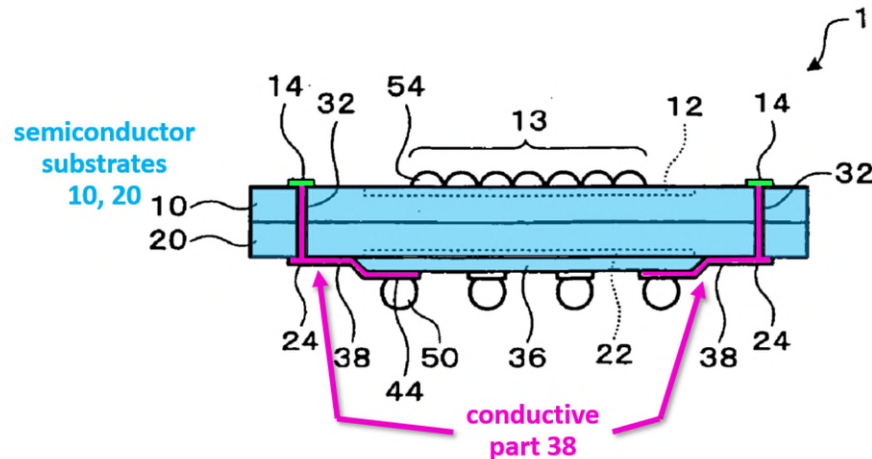
FIG. 1



(Ex. 1005, FIG. 1)

- d. at least one conducting channel passing through the chip and electrically connected to the first conducting pads at one end as well as extending along with a second surface of the chip

49. Imaoka discloses this limitation. For instance, Imaoka discloses conductive part 38 (*i.e.*, at least one conducting channel) is formed inside through-hole 32 and thus passes through the chip and is electrically connected to first pads 14 (*i.e.*, the first conducting pads) at one end. (See, *e.g.*, Ex. 1005, ¶¶0057–0065; FIGs. 1–7B.) In particular, Imaoka states “**conductive part 38 is formed inside the through-hole 32 [and] is electrically connected to at least one (both in FIG. 3) of the first and the second pad 14 and 24.**” (Ex. 1005, ¶0059; FIG. 3.)



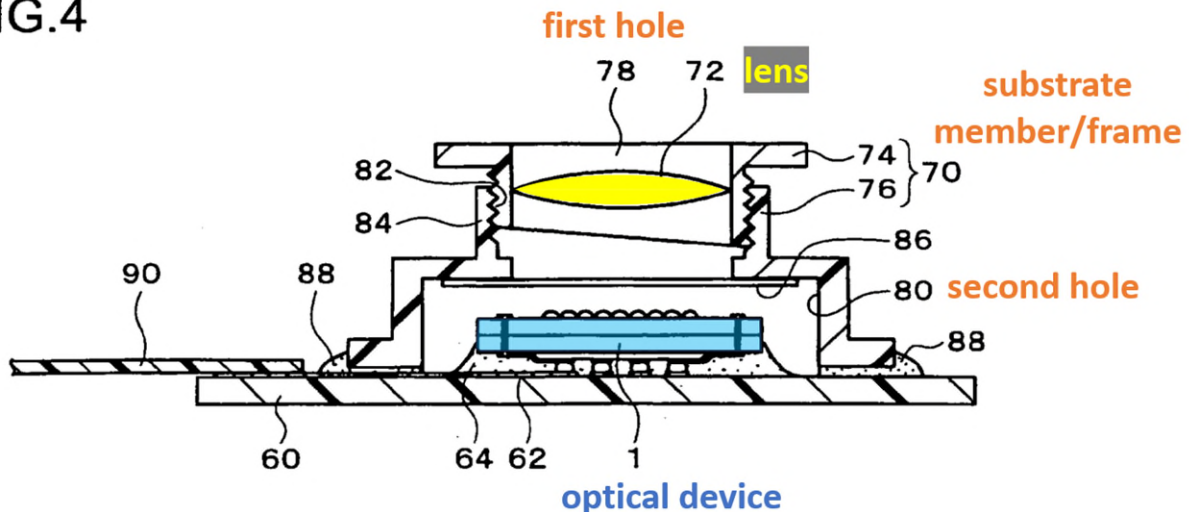
(Ex. 1005, FIG. 1.)

50. As illustrated in Figure 1 (above), Imaoka further discloses that, after passing through semiconductor substrates 10, 20, conductive part 38 extends along with a second surface of the chip. For instance, Imaoka states that “conductive part 38 has an electrical connection 44 [that] is formed on the side of the surface of the second semiconductor substrate 20 opposite to the first semiconductor substrate 10.” (Ex. 1005, ¶0060; FIGs. 1, 3.) This is also illustrated in Figure 1 above. As shown, conductive part 38 extends along the bottom surface of semiconductor substrate 20, which is in turn (at least in part) parallel to the bottom surface of semiconductor substrate 10. Hence, conductive part 38 extends in the same direction as the bottom surface of semiconductor substrates 10, 20.

e. a lens module comprising a holder having a through hole and a contact surface on a bottom of the holder

51. Imaoka and Seo each disclose and/or suggest this limitation. For instance, Imaoka discloses a lens module comprising substrate member 70 (*i.e.*, a holder) that holds a lens 72 and has a first and second hole 78, 80 (*i.e.*, a through hole) in communication with each other and surface (*i.e.*, a contact surface) on a bottom of substrate member 70 adhered to wiring substrate 60 by an adhesive 88. (See, *e.g.*, Ex. 1005, ¶¶0066–0073, FIG. 4.)

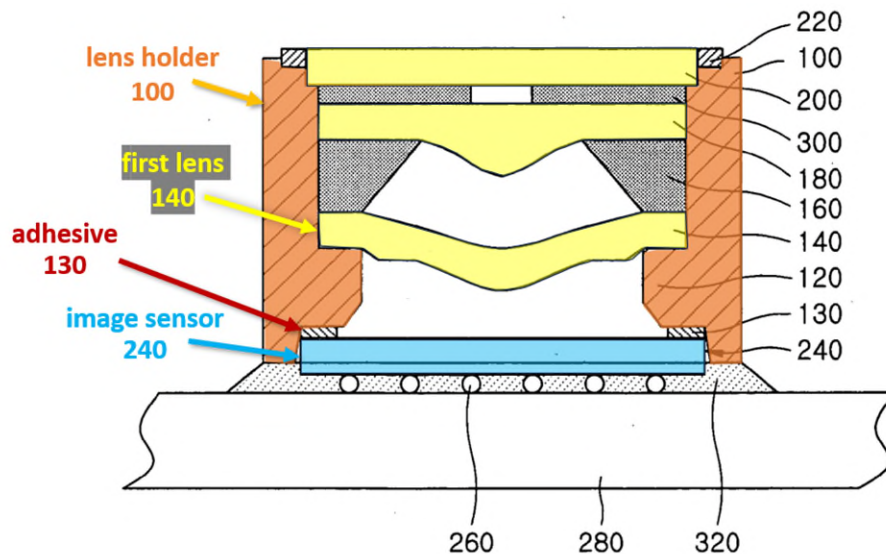
FIG.4



(Ex. 1005, FIG. 4.)

52. Seo also discloses a lens module comprising lens holder 100 (*i.e.*, a holder) with a hollow cylindrical body (*i.e.*, a through-hole) with embedded lenses 140, 180. (*See, e.g.*, Ex. 1006, abstract (“The image sensor camera module uses a **single-body type lens holder defined by a hollow cylindrical body**”), ¶¶0022–0023, 0030 (“As shown in FIG. 4, in operation S1, the first lens 140, the first spacer

160, the second lens 180, and the second spacer 300 are inserted into the single body type lens holder 100.”), FIGs. 2, 4, cl. 7 (“a lens holder defined by a **hollow cylindrical body with an axial opening therethrough into which first and second lenses are inserted**”).)



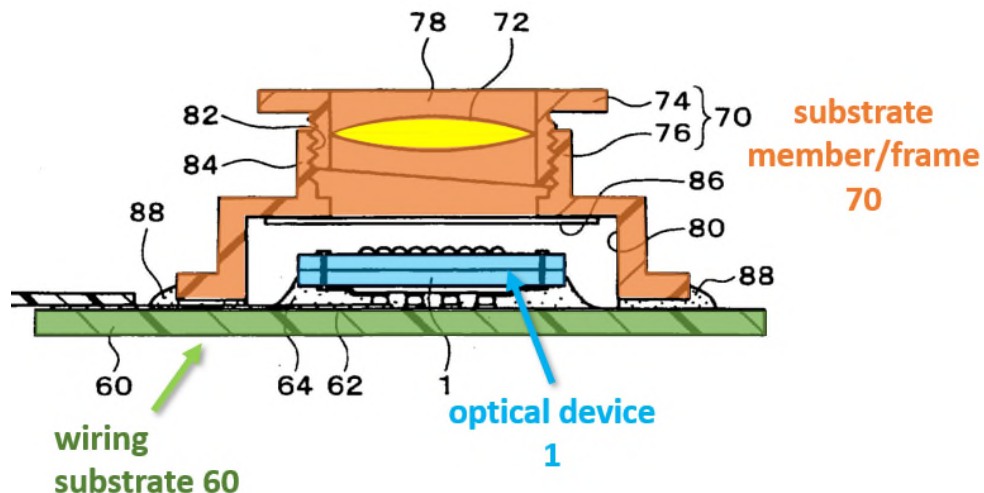
(Ex. 1006, FIG. 2.)

53. Seo further discloses that lens holder 100 has a shoulder 120 with an underside surface (*i.e.*, a contact surface) on a bottom of lens holder adhered to a top surface of the image sensor 240 by an adhesive 130. (*See, e.g.*, Ex. 1006, ¶¶0025 (“An upper surface (a surface opposite the surface that includes the connection terminals) of **an image sensor 240 is directly adhered to the inner surface of the lens holder 100** under the first lens 140. The image sensor 240 may be adhered to an underside of the shoulder 120 using an adhesive 130 as shown in FIG. 2.”)

54. Thus, whether considering Imaoka's disclosures alone, or in view of Seo's teachings, the modified Imaoka camera module (as discussed in further detail below) would have resulted in an image sensor module with the claimed features.

f. wherein the contact surface is combined with the first surface

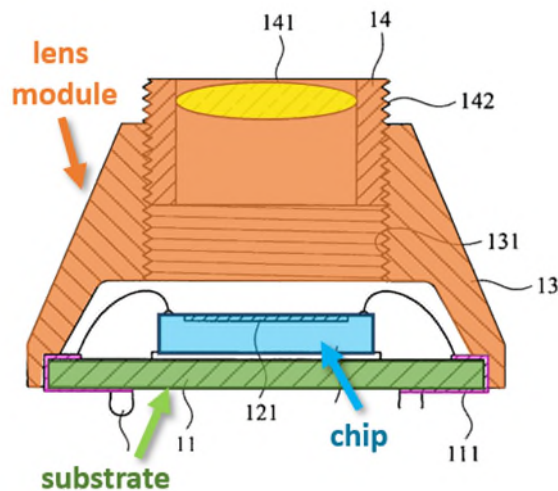
55. The combination of Imaoka and Seo discloses and/or suggests this limitation. As illustrated in Figure 4, Imaoka shows that a bottom surface of substrate member 70 is mounted to wiring substrate 60 with an adhesive 88. (See, *e.g.*, Ex. 1005, ¶¶0066–0069, FIGs. 1, 4.) Although image sensor (optical device 1) is also mounted to wiring substrate 60, a bottom surface of substrate member 70 is not “combined with” top surface of optical device 1 in any direct sense.



(Ex. 1005, FIG. 4.)

56. Indeed, as discussed above, the '602 patent attempted to distinguish conventional prior art arrangements, like Figure 1 (below), a “conventional” image

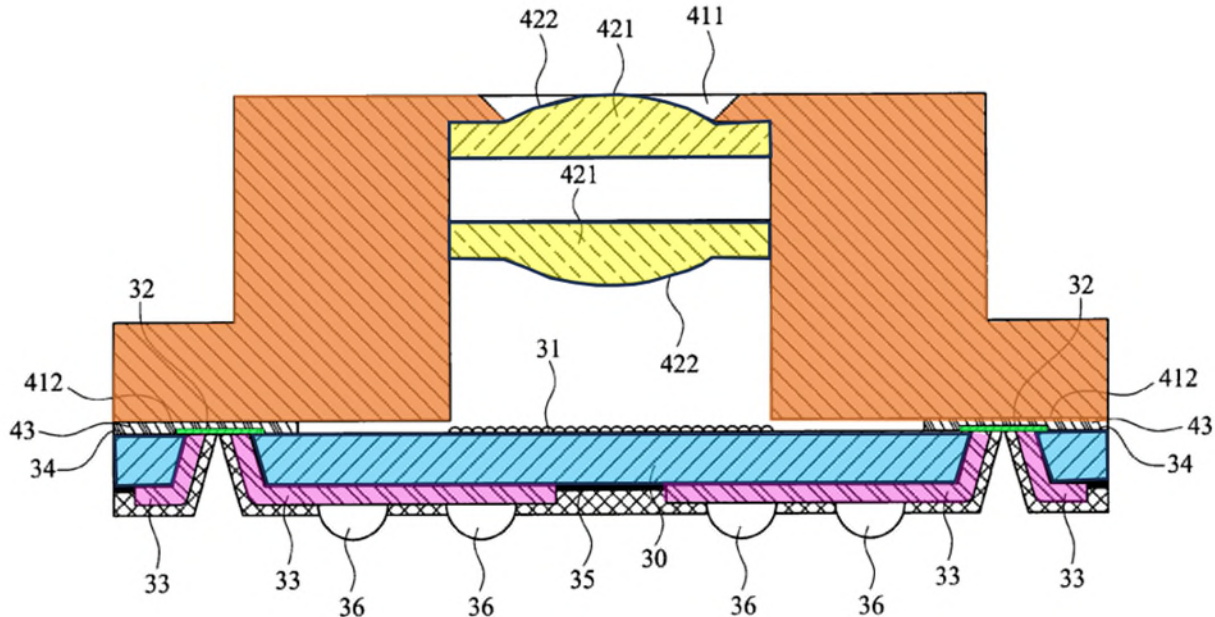
sensor structure, where “chip 12 is settled on the substrate 11 and includes a light-sensing element 121 thereon.” (Ex. 1001, 1:23–30.) “The lens seat 13 is formed with an inner threaded portion 131 and is settled on the substrate 11 so that a closed space 15 is defined between the lens seat 13 and the substrate 11 for accommodating the chip 12.” (Ex. 1001, 1:32–35.) In addition, “the lens barrel 14, having an outer threaded portion 142 that fittingly engages with the inner threaded portion 131 of the lens seat 13, is combined therein with at least one lens 141.” (Ex. 1001, 1:35–38.) It is then necessary to adjust the lens barrel 14 to properly focus the lens 141 onto the chip 12. (Ex. 1001, 1:48–54.)



(Ex. 1001, FIG. 1.)

57. The '602 patent states that “[b]y using an integrated lens module to assemble the image sensor structure, a procedure for setting a relative distance between a lens and a chip can be simplified, so that a manufacturing process of the

image sensor structure can be consequently simplified.” (Ex. 1001, 2:8–12; *see also id.* at 3:53–59 (“The holder 41 has a contact surface 34 of the chip 30 so that the lens module 40 can be directly combined with the first surface of the chip 30....”), FIG. 3).) This fixed-distance arrangement of the ’602 patent is illustrated below where the bottom contact surface 34 of the chip 30 is combined with a bottom contact surface 412 of the lens module.



(Ex. 1001, FIG. 3)

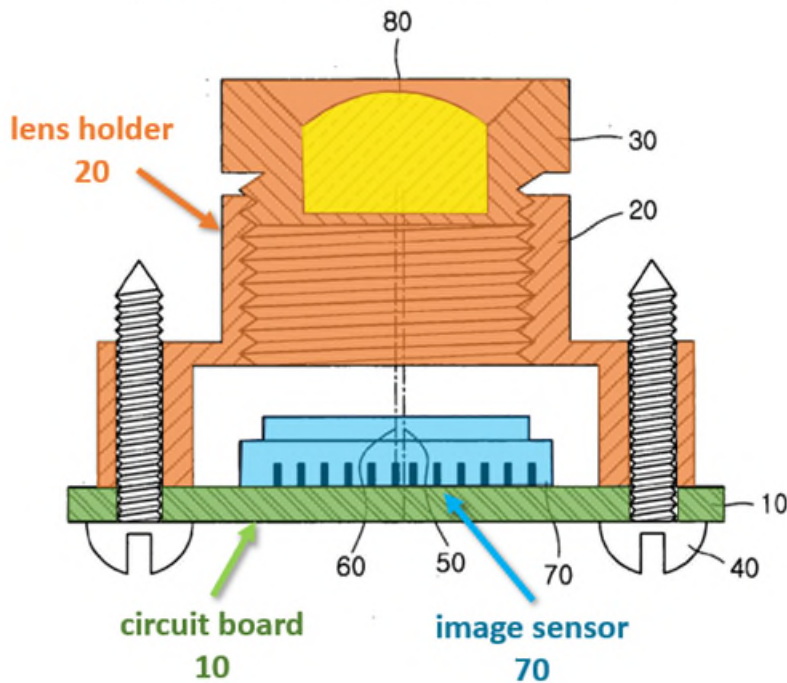
58. But this fixed-distance arrangement of an integrated lens module was disclosed by Seo. For instance, Seo discloses that lens holder 100 has a shoulder 120 with an underside surface (*i.e.*, a contact surface) on a bottom of lens holder 120 with an underside surface (*i.e.*, a contact surface) on a bottom of lens holder adhered to a top surface of the image sensor 240 by an adhesive 130. (*See, e.g.*, Ex. 1006, ¶0025 (“An upper surface (a surface opposite the surface that includes the

connection terminals) of **an image sensor 240 is directly adhered to the inner surface of the lens holder 100 under the first lens 140.** The image sensor 240 may be adhered to an underside of the shoulder 120 using an adhesive 130 as shown in FIG. 2.”). Thus, Seo discloses this the claimed limitation.

59. Further, Seo suggests modifying Imaoka’s image sensor module such that a contact surface of a lens holder is directly combined with the first surface of an image sensor chip, namely, the complexity of having to accurately set the positioning of a lens relative to the image sensor chip so the camera is properly focused. (Ex. 1006, ¶¶0005–0010, 0027, 0038–0040.)

60. For instance, Seo describes a conventional image sensor camera module, as illustrated below, which is similar to the conventional image sensor module described in the ’602 patent and has the same drawbacks. Seo’s prior art image sensor camera module is completed by separately assembling the lens holder 20 and the image sensor 70 attached to the circuit board 10. (Ex. 1006, ¶¶0007–0008, FIG. 1.) This arrangement necessarily requires alignment and adjustment of the lens 80 relative to the image sensor 70 to achieve proper focus. (*Id.*) Seo explains that this may negatively impact the accuracy and reliability of the camera module. (*Id.*)

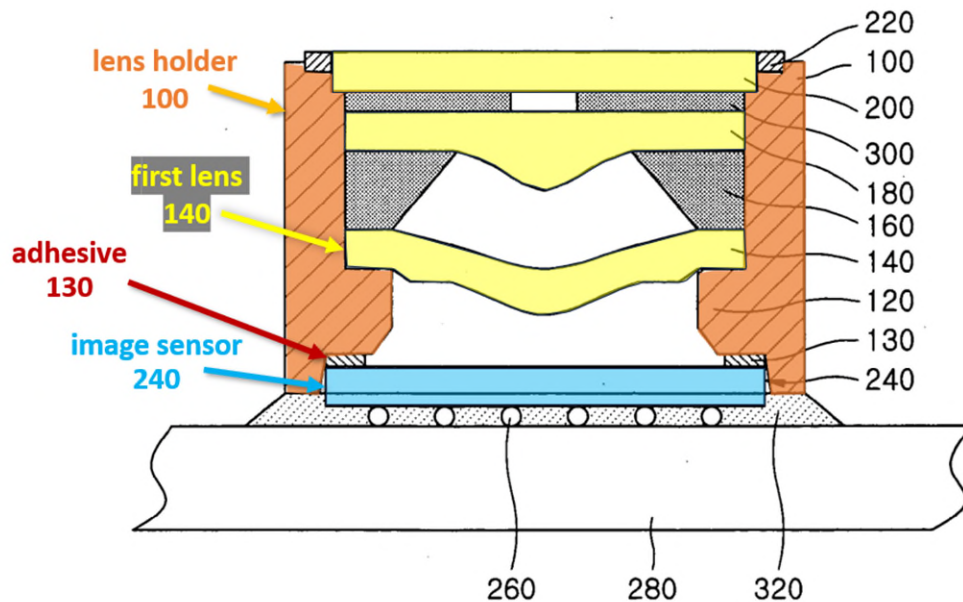
FIG. 1 (PRIOR ART)



(Ex. 1006, FIG. 1)

61. To address these drawbacks of the prior art, Seo proposes “an image sensor camera module which can be assembled without adjusting a focal length between a lens and in image sensor.” (Ex. 1006, ¶0009.) In particular, Seo discloses an image sensor camera module including a lens holder, one or more lenses installed inside the lens holder, an image sensor including an upper surface directly adhered to an inner surface of the lens holder. (Ex. 1006, ¶¶0012, 0022–0027; FIG. 2.) As a result, the lenses do not need to be adjusted as in the prior art, the assembly process is simplified, and “the probability of error or inaccuracy in fabricating the image sensor camera module is low when compared to that of the conventional image sensor camera module.” (Ex. 1006, ¶0027.)

FIG. 2



(Ex. 1006, FIG. 2)

62. Notably, Imaoka and Seo are both from the same field of endeavor as the '602 patent (*i.e.*, image sensor structures and integrated lens modules. (See Ex. 1001, 1:6–12.) As discussed above, both Imaoka and Seo address the same or similar problems as purportedly addressed by the '602 patent (*e.g.*, reducing size, simplifying assembly, and lowering costs). (See Ex. 1001, 2:7–20.) Accordingly, a POSITA would have considered the teachings of Imaoka and Seo in designing an image sensor module.

63. Additionally, POSITA would have been motivated to configure Imaoka's image sensor module by mounting a bottom surface of the substrate member/lens holder (like that of Seo) directly to the upper surface of an image sensor

chip (like that of Imaoka) in view of Seo's teachings and the knowledge of a POSITA. A POSITA would have been motivated to implement such a modification, *e.g.*, to simplify the assembly of the image sensor module, avoid having to adjust the focus lens, and thereby reduce costs and improve the accuracy and repeatability of the process, as discussed by Seo. (Ex. 1006, ¶¶0038–0040 (describing the advantages of Seo's approach).)

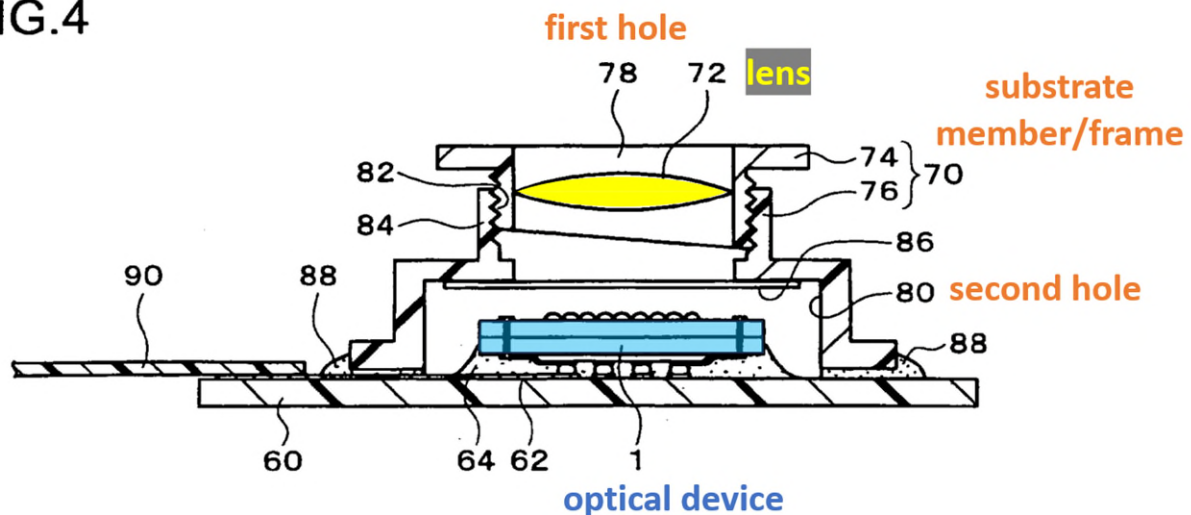
64. A POSITA would have been able to implement the image sensor chip of Imaoka in view of Seo's teachings with an expectation of success. Such a modification would have involved known design techniques and components consistent with that known by a POSITA. For example, Seo provides examples of how to assemble a lens holder and image sensor (*e.g.*, as described in the flowchart of Figure 3 and illustrated in Figures 4–9), such as through the use of an adhesive. (Ex. 1006, ¶¶0028–0038.)

g. at least one lens completely embedded inside the through hole and integrated with the holder

65. Imaoka and Seo each disclose and/or suggest this limitation. For instance, Imaoka discloses that the substrate member 70 can be an integrated constructed with one member from the first part 74 and second part 76 and the lens 72 is attached to the first part 74 and fixed to inside the first through hole 78. (See, *e.g.*, Ex. 1005, ¶¶0068, 0069, FIG. 4 (reproduced below). Imaoka also discloses a

lens 72 completely enclosed by inside first hole 78 as shown in Figure 4 below. (Ex. 1005, ¶0069 (“The substrate member 70 includes a first and a second part 74 and 76. The lens 72 is attached to the first part 74. ... In particular, the first part 74 has a first hole 78 and the lens 72 is held inside the first hole 78.”))

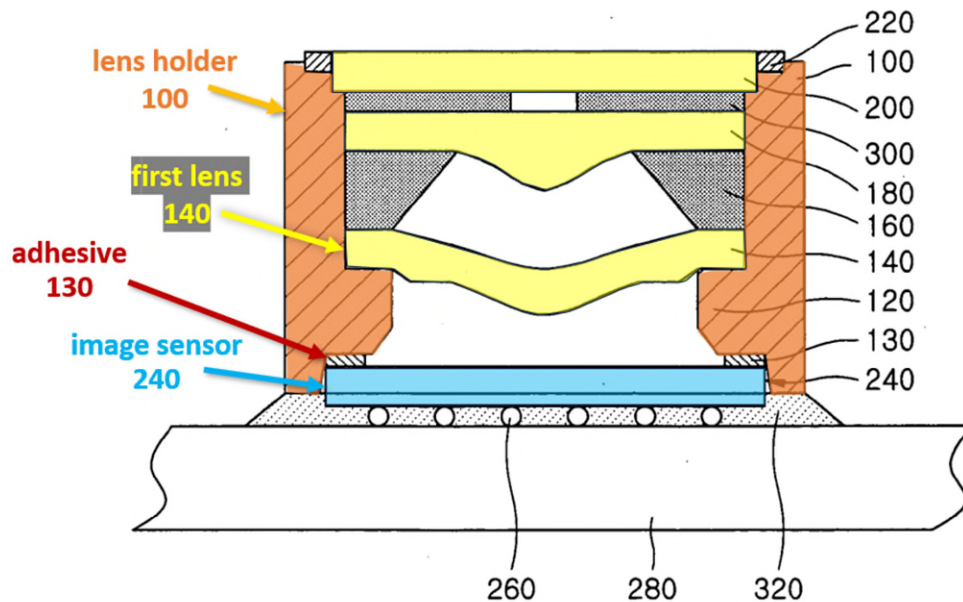
FIG.4



(Ex. 1005, FIG. 4.)

66. Seo also discloses this limitation. For instance, Seo discloses a lens holder “defined by a single generally cylindrical body having an opening extending axially therethrough” and a first lens (*i.e.*, a least one lens) “installed inside the lens holder.” The lens 140 is securely adhered to the shoulder 120 inside the lens holder 100. The uniform dimensions of the holder 100 and the shoulder 120 integrally formed therewith supports the first lens 140 in a fixedly predetermined position, thus defining a fixed focal length or distance and a fixed focal axial alignment. (Ex. 1006, ¶0010; *see also id.* at ¶¶0012–0015, 0022–0023, 0031, 0032, FIGs. 2–4.)

FIG. 2



(Ex. 1006, FIG. 2)

67. Based on the above description, a POSITA would have understood from Seo's description and the accompanying figures that at least lens 140 and lens 180 is completely embedded inside the through hole and integrated with the holder.

68. Thus, whether considering Imaoka's disclosures alone, or in view of Seo's teachings, the modified Imaoka camera module (as discussed in further detail above) would have resulted in an image sensor module with the claimed features.

2. Claim 2 – The image sensor structure as claimed in claim 1, wherein the chip is a complementary metal oxide semiconductor (CMOS) image sensor chip

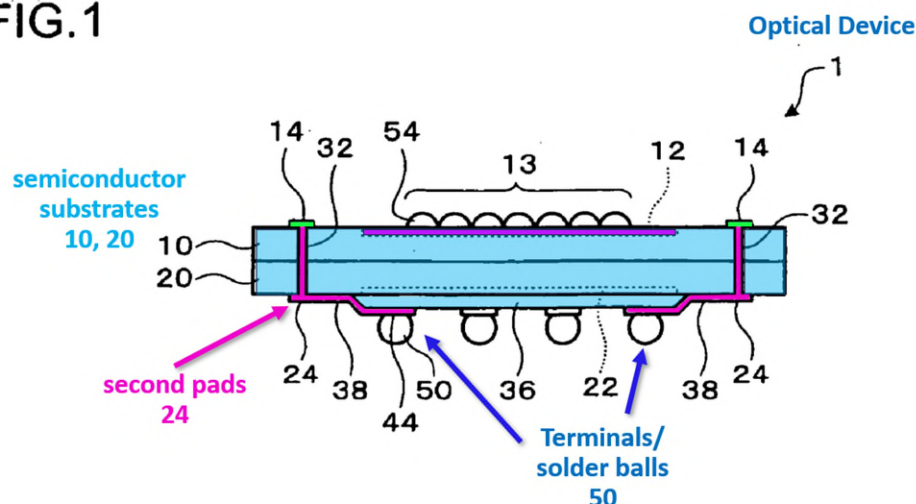
69. Imaoka discloses this limitation. For instance, Imaoka discloses the chip is a complementary metal oxide semiconductor (CMOS) image sensor chip. (Ex. 1005, ¶10052 (“[T]he optical device may be an image sensor (for example a CCD

image sensor or a CMOS image sensor.”) A POSITA would have understood “CMOS image sensor” to refer to a complementary metal oxide semiconductor (CMOS) image sensor chip. (Ex. 1006, ¶0026 (“Here, the image sensor 240 may be a suitable Charge Coupled Device (CCD) or a Complementary Metal-Oxide-Semiconductor (CMOS) image sensor”.)

3. Claim 3 – The image sensor structure as claimed in claim 1, wherein the chip further comprises a plurality of second conducting pads or balls which are arranged on the second surface of the chip and electrically connected to the conducting channel

70. Imaoka discloses this limitation. For instance, Imaoka discloses a plurality of second pads 24 (*i.e.*, second conducting pads) and solder balls 50 (*i.e.*, a plurality of balls) which are arranged on the second surface of the semiconductor substrates 10, 20 and electrically connected to the conductive part 38 (*i.e.*, the conducting channel). (Ex. 1005, ¶¶0056–0060, FIGs. 1–3.)

FIG.1

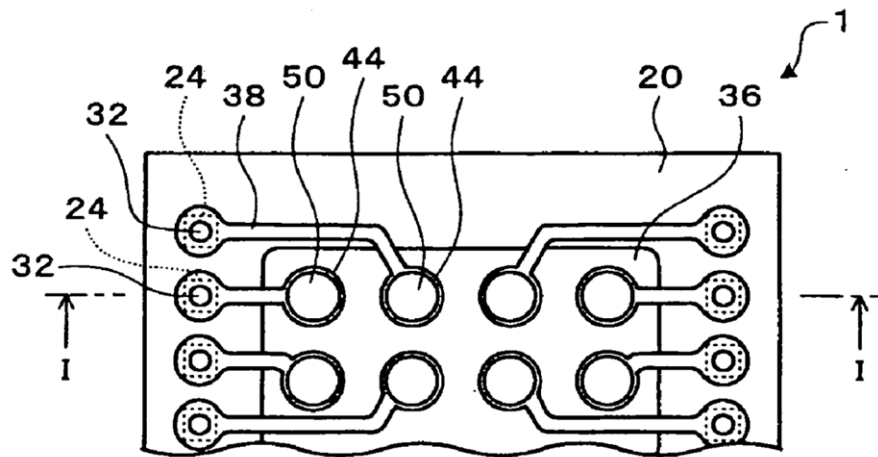


(Ex. 1005, FIG. 1.)

4. **Claim 4 – The image sensor structure as claimed in claim 1, wherein the chip further comprises a ball grid array which is arranged on the second surface of the chip and electrically connected to the conducting channel**

71. Imaoka discloses this limitation. For instance, Imaoka discloses the semiconductor substrates 10, 20 includes solder balls 50 (*i.e.*, a ball grid array) is arranged on the second surface of the chip and electrically connected to the conductive part 38 (*i.e.*, the conducting channel). (Ex. 1005, ¶¶0056–0060, FIGs. 1–3.)

FIG.2

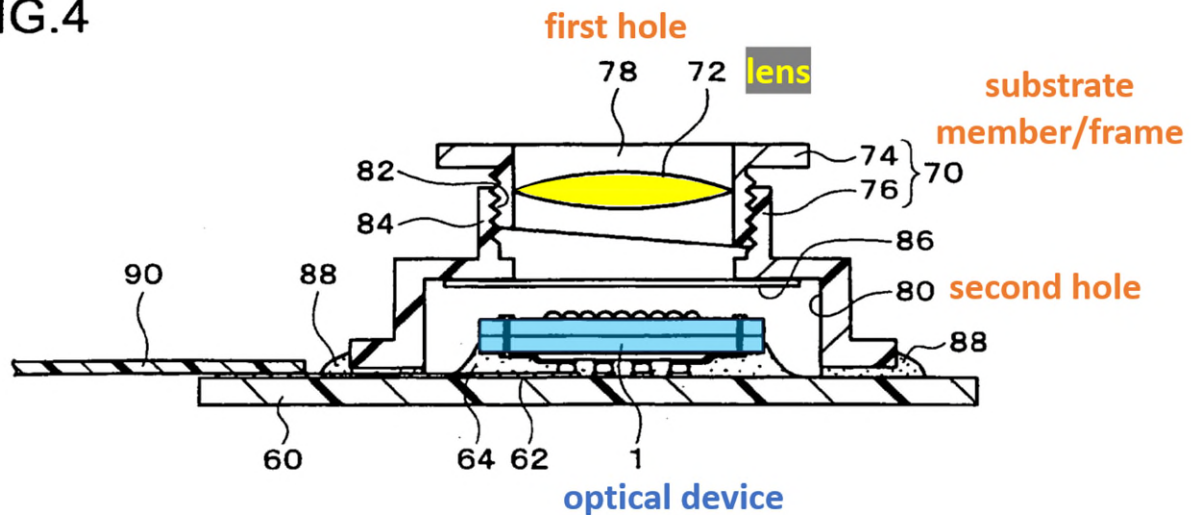


(Ex. 1005, FIG. 2.)

5. **Claim 5 – The image sensor structure as claimed in claim 1, wherein a cavity is formed at the bottom of the holder**

72. Imaoka discloses this limitation. For instance, Imaoka discloses a second hole 80 (*i.e.*, a cavity) is formed at the bottom of the holder. (Ex. 1005, ¶¶0070, FIG. 4.)

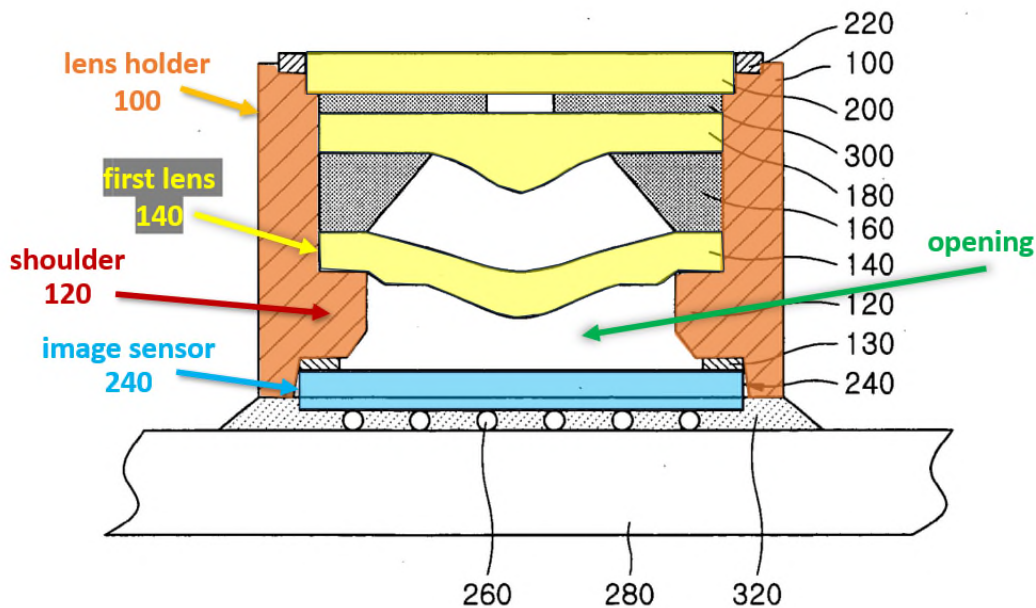
FIG.4



(Ex. 1005, FIG. 4.)

73. Seo discloses, *e.g.*, an opening (*i.e.*, a cavity) between shoulder 120 is formed at the bottom of the lens holder 100, as shown in Figure 2. (Ex. 1006, ¶¶0010, 0022, 0023, 0031, 0032, FIG. 2, 4.)

FIG. 2



(Ex. 1006, FIG. 2.)

74. Thus, whether considering Imaoka's disclosures alone, or in view of Seo's teachings, the modified Imaoka camera module (as discussed in further detail above) would have resulted in an image sensor module with the claimed features.

6. Claim 6 – The image sensor structure as claimed in claim 1, wherein the holder is made of a plastic material or a metal material.

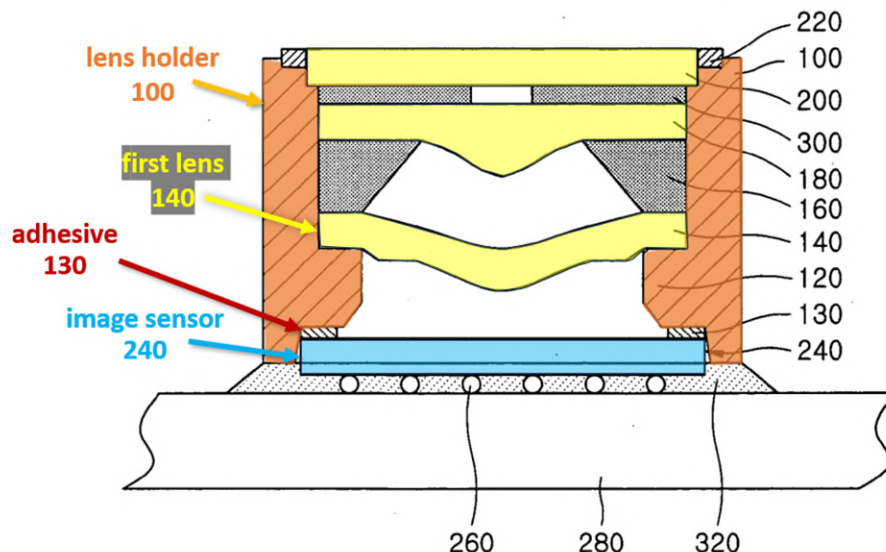
75. Imaoka and Seo each disclose this limitation. For instance, Imaoka discloses "substrate member 70 is formed of a light-shielding material (for example, a resin or a metal)" and hence discloses that the substrate member that holds lens 72 may be made of a metal material). (Ex. 1005, ¶0068.) Moreover, Seo discloses lens holder 100 "can be made of a material intercepting radio waves such as a plastic material or a metallic material." (Ex. 1006, ¶0024.)

76. Thus, whether considering Imaoka's disclosures alone, or in view of Seo's teachings, the modified Imaoka camera module (as discussed in further detail below) would have resulted in an image sensor module with the claimed features.

7. Claim 7 – The image sensor structure as claimed in claim 1, wherein the contact surface is combined with the first surface by an adhesive

77. Imaoka and Seo each disclose this limitation. For instance, Imaoka discloses that “substrate member 70 may be bonded to the wiring substrate 60 with an adhesive 88.” (Ex. 1005, ¶0068, FIG. 4.) Further, Seo discloses that “image sensor 240 may be adhered to the underside of the shoulder 120 using adhesive 130 as shown in FIG. 2.” (Ex. 1006, ¶¶0024, 0034, FIG. 2.)

FIG. 2



(Ex. 1006, FIG. 2.)

78. Thus, whether considering Imaoka's disclosures alone, or in view of Seo's teachings, the modified Imaoka camera module (as discussed in further detail above) would have resulted in an image sensor module with the claimed features.

8. Claim 8 – The image sensor structure as claimed in claim 1, wherein the contact surface is combined with the first surface by an UV curable adhesive.

79. Seo discloses this limitation. For instance, Seo discloses that “adhesive 130 is any suitable adhesive and preferably is a thermosetting adhesive.” (Ex. 1006, ¶0034.) A POSITA would have understood a suitable adhesive to include a UV curable adhesive based on Seo disclosure. (Ex. 1006, ¶0036 (“Those of skill in the art will appreciate that ... a thermosetting adhesive [] is capable of readily being hardened, e.g., [by] the application of heat or UV radiation.”))

80. Thus, in view of Seo's teachings as to how to combine a lens module with an image sensor chip, the modified Imaoka camera module (as discussed in further detail above) would have resulted in an image sensor module with the claimed features.

9. Claim 9 – The image sensor structure as claimed in claim 1, wherein the lens is a plastic lens.

81. The Imaoka-Seo combination discloses/suggests this limitation. As explained above, the Imaoka-Seo combination would have included at least one lens in the substrate member/lens holder with respect to claim 1. Although Imaoka does

not expressly disclose what material the lens is made out of, a POSITA would have needed to choose a suitable material for the lens or lenses of the camera module. And plastic was a well-known suitable material for lenses as exemplified by Seo. Seo teaches that first and second lenses 140 and 180 “may be made of any suitable glass, plastic, or other optical quality material” for use within an image sensor camera module. (Ex. 1006, ¶0024.)

82. Thus, in light of Seo and the known materials suitable for lenses, a POSITA would motivated to choose an appropriate material for the camera lens module depending on the application. Like Imaoka, Seo teaches suitable materials for use in mobile phones and digital cameras. (See Ex. 1005, ¶0093; Ex. 1006, ¶0001.) Therefore, a POSITA would have been motivated to configure the Imaoka-Seo camera module to include a lens with an appropriate material, such as plastic.

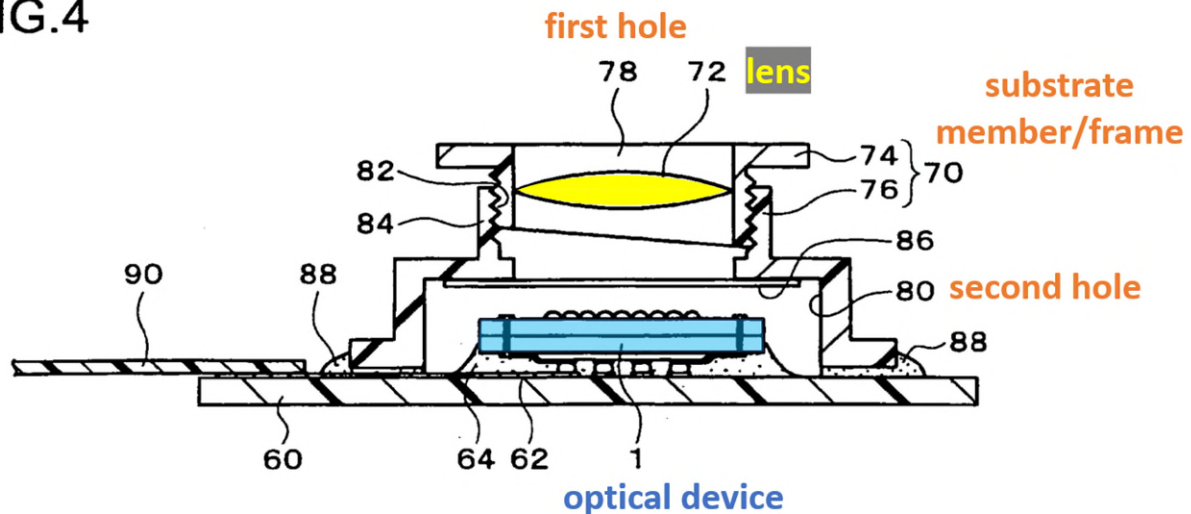
83. Further, plastic lenses were also well known in the art to have certain advantages, such as relatively low cost and light weight, which would have provided additional motivation to select plastic as a material for the lens. Furthermore, such a modification would have allowed the lens to be formed with known materials using known technologies/techniques (as demonstrated by Seo) leading to a reasonable expectation of success.

10. Claim 10 – The image sensor structure as claimed in claim 9, which further comprises an IR cut filter glass which is embedded in the through hole and arranged below the plastic lens.

84. The Imaoka-Seo combination discloses/suggests this limitation. For instance, Imaoka discloses the optical module includes an optical filter 86 below lens 72. (Ex. 1005, ¶0071.) Imaoka states that “optical filter 86 may be a filter which transmits only light having a specific wavelength (for example, visible light) or a filter having a small loss with respect to light of a specific wavelength (for example, visible light).” (Ex. 1005, ¶0071.) In other words, the filter may cut out nonvisible light, such as infrared radiation. (Ex. 1005, ¶0071 (disclosing optical filter 86 may be an “infrared shield coat (IR coat).”))

85. Further, Imaoka discloses that “optical filter 86 may be attached to the substrate member 70 (for example, the second hole 80).” (Ex. 1005, ¶0071.) As illustrate in Figure 4, optical filter 86 is embedded in the first/second hole 78, 80 (*i.e.*, the through hole) and arranged below the lens 72.

FIG.4



(Ex. 1005, FIG. 4.)

86. Thus, the Imaoka-Seo combination suggests an IR cut filter in the substrate member/lens holder below a plastic lens. (*See also* my analysis of claim 9.)

87. Although Imaoka does not expressly disclose the IR cut filter is an IR cut filter glass, a POSITA would have been motivated to choose a suitable material for the filter of the image sensor module and glass was well known suitable material for lenses. For example, consistent with the knowledge of a POSITA, Seo teaches that filter 200 (which may be an IR filter) “may be made of any suitable glass, plastic, or other optical quality material” for use within an image sensor camera module. (Ex. 1006, ¶¶0024, 0031.)

88. In light of Seo and a POSITA's knowledge of suitable materials, a POSITA would have been motivated to configure the Imaoka-Seo image sensor module to include an IR cut filter of an appropriate material, such as glass.

89. Further, IR cut filters made on or from glass were also well known in the art to have certain advantages, which would have provided additional motivation to select glass as a material for the filter. Furthermore, such a modification would have allowed the lens to be formed with known materials using known technologies/techniques (as demonstrated by Seo) leading to a reasonable expectation of success.

11. Claim 11 – The image sensor structure as claimed in claim 1, wherein the lens is a glass lens.

90. The Imaoka-Seo combination discloses/suggests this limitation. As explained above, the Imaoka-Seo combination would have included at least one lens (such as lens 72 in Imaoka or lenses 140, 180 in Seo) in the substrate member/lens holder. (See my discussion of claim 1.) For similar reason to those addressed in claim 9, a POSITA would have looked to choose a suitable material for any of the lenses of the lens module. Consistent with the knowledge of a POSITA, Seo teaches that first and second lenses 140 and 180 “**may be made of any suitable glass, plastic, or other optical quality material**” for use within an image sensor camera module. (Ex. 1006, ¶0024.)

91. Further, glass lenses were also well known in the art to have certain advantages, such as relatively high durability and performance, which would have provided additional motivation to select glass as a material for the lens. Furthermore, such a modification would have allowed the lens to be formed with known materials using known technologies/techniques (as demonstrated by Seo) leading to a reasonable expectation of success.

12. Claim 12 – The image sensor structure as claimed in claim 11, wherein the glass lens is coated with an IR cut filtering layer

92. The Imaoka-Seo combination discloses/suggests this limitation. As I explained above regarding claim 11, POSITA would have been motivated to select glass as a material for a lens in the image sensor module, such as lens 72. Further, Imaoka discloses that “lens 72 may be equipped with a function of the optical filter 86 ... such as an infrared shield (IR coat).” (Ex. 1005, ¶0071.) Thus, a POSITA would have understood Imaoka to disclose a lens coated with an IR cut filtering layer as claimed.

13. Claim 13 – The image sensor structure as claimed in claim 1, wherein the lens comprises a glass lens and a plastic lens, wherein the glass lens is arranged below the plastic lens

93. The Imaoka-Seo combination suggests this feature. Although Imaoka only discloses a single focusing lens for the camera module, it was well known that camera modules conventionally included more than one lens, as exemplified by Seo,

which discloses two lenses 140 and 180. (Ex. 1006, ¶0023.) Camera modules often utilized more than one lens to allow for formation of a better focused image. For example, the use of multiple lenses could correct for optical aberration inherent in a single optical lens, such as chromatic aberration, astigmatism, field distortion, and other aberrations.

94. Further, as discussed above, the choice of materials for such lens systems was routine part of optical design. Material selection could depend of the desired characteristics of the lens individually (*e.g.*, lighter weight or higher durability) or as a system (*e.g.*, aberrations created by a lens of one material may be compensated for by a lens of a different material). Thus, selection of the number of lenses and choice of materials was a matter of routine design choice. For instance, consistent with the knowledge of a POSITA, Seo teaches an optical system with first and second lenses 140 and 180 that “may be made of any suitable glass, plastic, or other optical quality material” for use within a camera module. (Ex. 1006, ¶¶0001, 0023–0024.) Hence, a POSITA would have envisioned suitable two-lens arrangements from a limited number of configurations, such as a glass lens and a plastic lens, wherein the glass lens is arranged below the plastic lens.

95. In light of Seo and a POSITA’s knowledge of suitable materials, a POSITA would have been motivated to configure the Imaoka-Seo image sensor

module to include two lenses with an appropriate material, such as glass and plastic, including herein the glass lens is arranged below the plastic lenses. Furthermore, such a modification would have allowed the lenses to be formed with known materials using known technologies/techniques (as demonstrated by Seo) leading to a reasonable expectation of success.

14. Claim 14 – The image sensor structure as claimed in claim 13, wherein the glass lens is coated with an IR cut filtering layer

96. The Imaoka-Seo combination discloses/suggests this limitation for the same reasons as I discussed regarding claim 12.

15. Claim 15 – The image sensor structure as claimed in claim 13, which further comprises an IR cut filter glass which is embedded in the through hole and arranged below the plastic lens

97. The Imaoka-Seo combination discloses/suggests this limitation for the same reasons as I discussed regarding claim 10.

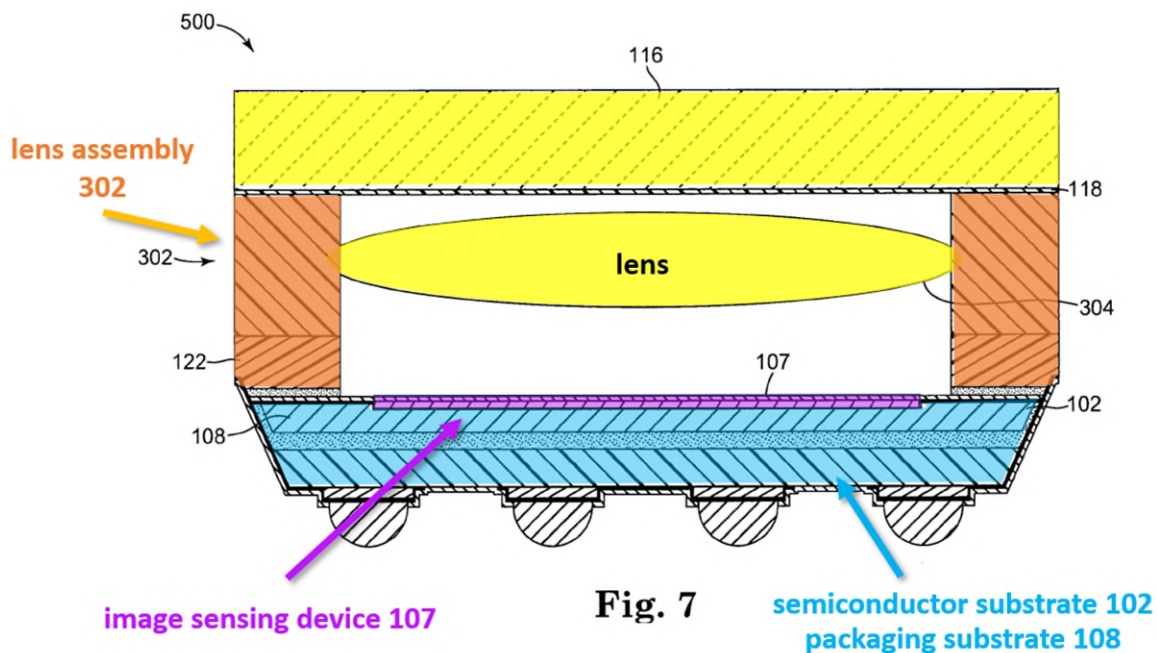
B. Ground II – Ma and Wood disclose and/or suggest all the features of Claims 1–7, 9–11, 13, and 15

1. Claim 1

98. Ma and Wood disclose and/or suggest every limitation of claim 1 of the '602 patent, as I discuss in further detail below.

a. An image sensor structure with an integrated lens module

99. As I noted above, I have been asked to consider the preamble and give it weight. I find that Ma discloses this feature. For example, Ma discloses an integrally packaged imaging module (*i.e.*, an image sensor structure) including a lens support (*i.e.*, an integrated lens module). *See, e.g.*, Ex. 1007, ¶¶0001, 0012, 0018–0023, 0027–0029, 0031, 0040 (“One embodiment of such a camera module includes an integrally packaged lens aligned to focus an image onto the image sensing device 107.”), FIGs. 1A, 3A, 3B, 4, 5A–5C, 7–8, and 9 (reproduced below). For example, Ma discloses a camera module 500 according to one embodiment. *Id.*



(Ex. 1007, FIG. 7 (illustrating one camera module embodiment).)

100. Additionally, the Ma-Wood combination discloses or suggests each of the remaining features of claims 1–7, 9–11, 13, and 15 for the reasons presented in the following sections.

101. Notably, Ma discloses several embodiments that include many of the claim features, particularly embodiments described in connection with Figures 4 and 7–9. Any of these embodiments could have been modified with Woods teachings as described below and a POSITA would have been motivated to do so for the reason discussed in further detail below.

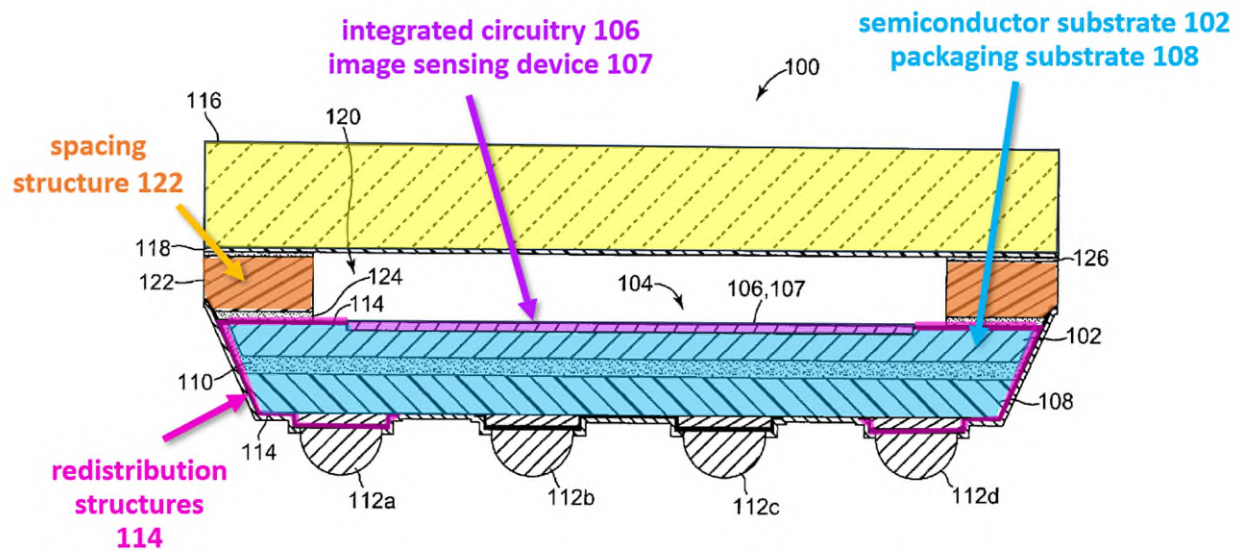
102. I further note that Ma describes several aspects of the image sensor module 100 in relation to the embodiment of Figure 1, such as semiconductor substrate 102, redistribution structures 114, and electrical connections 112. Although Ma does not repeat that disclosure with respect to the other embodiments, the figures for those embodiments clearly illustrate those same components and a POSITA would have understood them to be present although the description of those aspects might not be repeated. (*See, e.g.*, Ex. 1007, ¶0050 (“The camera module 200a [shown in Figure 3A] includes semiconductor substrate 102, image sensing device 107, packaging substrate 108, electrical contacts 112, and redistribution structures 114.”), ¶¶0058, 0072, 0073, 0075.)

b. a chip having a plurality of light-sensing elements arranged on a light-sensing area of a first surface of the chip

103. Ma discloses this limitation. For example, Ma discloses an imaging module 100 (*which is also included in camera modules 200, 250, 300, etc.*) having semiconductor substrate 102, which “includes an active area 104 containing integrated circuitry 106, which includes an image sensing device 107, an image processor, interface logic, and power conditioning circuitry.” (Ex. 1007, ¶¶0031–0034, 0050, FIGs. 1, 3A.) Ma states that semiconductor substrate 102 has an integrated circuit 106 (including, *e.g.*, an image sensing device 107 and associated circuitry) and associated electrical connections (*e.g.*, electrical contacts 112 and redistribution structures 114). (*Id.*) Thus, a POSITA would have understood Ma’s first imaging module 100 to include a “chip” as construed by the court.

104. For similar reasons, a POSITA would have considered Ma’s combined semiconductor substrates 102, 108 may be considered a “chip” as claimed by virtue of their combined wafer-level packaging. (Ex. 1007, ¶0032 (“Imaging module 100 includes wafer-level packaging enclosing the semiconductor substrate 102. Wafer-level packaging technology is generally known in the art, and is sometimes referred to as **chip**-scale packaging (CSP). Wafer-level packaging technology permits integrated circuits formed on a wafer to be packaged for end-product use before being individually separated from the wafer by a dicing process.”).)

105. Ma further discloses that image sensing device 107 (*e.g.*, a CMOS image sensor) has light-sensing pixels (*i.e.*, a plurality of light-sensing elements) arranged on an active area 104 (*i.e.*, a light-sensing area) of a first surface of the semiconductor substrate 102. (Ex. 1007, ¶0031, FIG. 1; *see also id.*, ¶0039, 0050.)

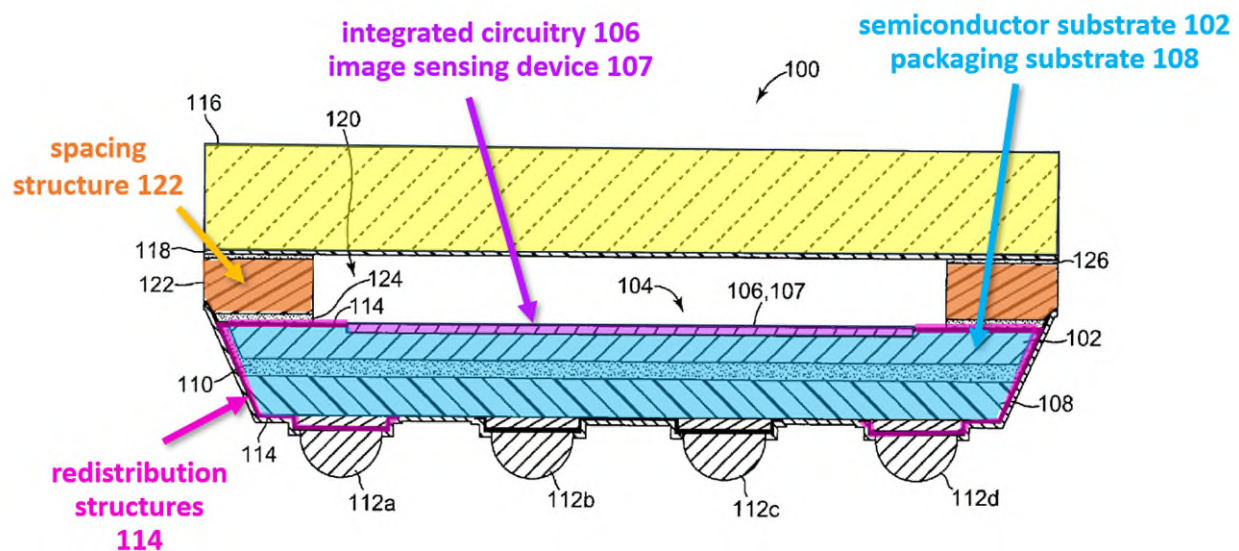


(Ex. 1007, FIG. 1.)

106. Based on the disclosure of Ma discussed above, a POSITA would have understood Ma to disclose a chip having a plurality of light-sensing elements, such as light-sensing pixels, arranged on a light-sensing area of a first surface of the semiconductor chip as claimed.

- c. a plurality of first conducting pads arranged around the light-sensing area and electrically connected to the light-sensing elements
- d. at least one conducting channel passing through the chip and electrically connected to the first conducting pads at one end as well as extending along with a second surface of the chip

107. Ma and Wood disclose and/or suggest these limitations. For instance, Ma discloses the “[f]or connecting electrical contacts 112 to integrated circuitry 106, imaging module 100 employs redistribution structures 114.” (Ex. 1007, ¶0034.) As illustrated in Figure 1 (below), redistribution structures 114 are formed along the surfaces of semiconductor substrate 102, packaging substrate 108, and adhesive layer 110 at least at opposing sides of the of active area 104 (i.e., a light-sensing area). (*Id.*)



(Ex. 1007, FIG. 1.)

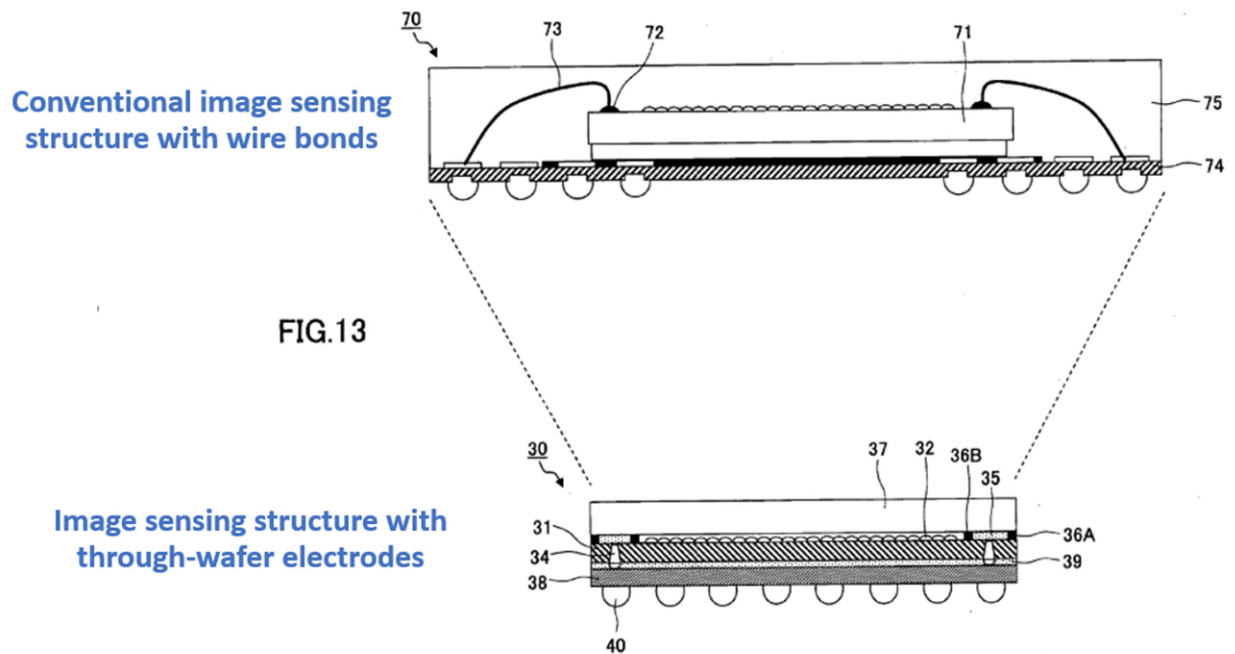
108. As was understood in the art, “imaging modules generally include an image sensor that detects an image and converts it into an electrical signal representation.” (Ex. 1007, ¶0003.) Additionally, “[e]lectrical contacts provide connectivity between the imaging modules and the end products incorporating the imaging modules.” (*Id.*) In light of these teachings and a POSITA’s ordinary knowledge of image sensors, a POSITA would have understood that Ma’s redistribution structures 114 electrically connect to the pixels (*i.e.*, light-sensing elements) of the image sensor 107. Further, as illustrated above, Ma’s redistribution structures 114 form a conducting channel passing around the substrates 102, 108 and extend along with a second surface of the substrates.

109. Ma also notes, however, that the form of the redistribution structures 114 is not limited to the arrangement shown in Figure 1. Specifically, Ma states that “[i]t will be recognized by one skilled in the art that a variety of wafer level/CSP technologies can be used for creating redistribution structures 114 that connect input/output nodes of the integrated circuitry 106 to the electrical contacts 112 within the wafer-level packaging.” (Ex. 1007, ¶0034.)

110. Other suitable techniques used for creating redistribution structures 114 were well known in the art and, techniques such as through-silicon vias (TSV), in particular, are described by Wood and others. (*See, e.g.*, Ex. 1008, ¶0045, FIG. 2;

see also Ex. 1009, ¶¶0005–0012, 0094–0101, FIG. 14; Ex. 1010, ¶¶0053–0054, 0088–0092, FIGs. 5, 13.)

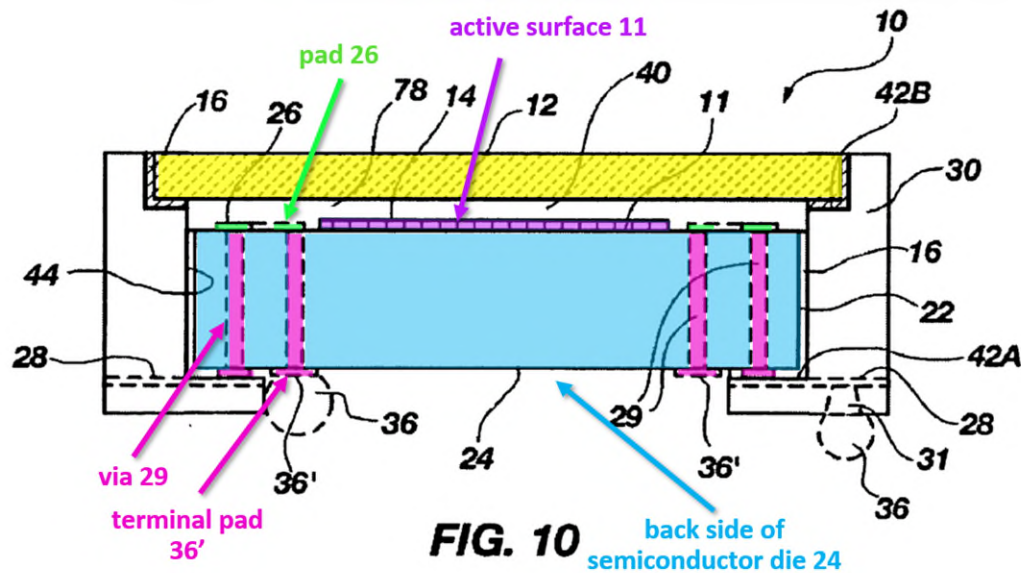
111. Wood is directed to semiconductor die-based image sensors and thus from the same field of endeavor as the '602 patent. (*See, e.g.*, Ex. 1001, 1:7–2:45; Ex. 1008, ¶¶0003–0007, 0015, 0019.) Wood also describes solutions to reduce the size and fabrication cost of an image sensor module and thus addresses a similar problem to the '602 patent. (*See, e.g.*, Ex. 1001, 1:7–2:45; Ex. 1008, ¶¶0005, 0025.) One of those solutions to reducing size is to use a through-wafer technique, which alleviates the need for wire bonds/outer electrical connections and allows a reduction in the overall size of a chip-scale image sensor package. (*See* Ex. 1005, ¶¶0004–0006, 0021–0035; Ex. 1008, ¶0045; Ex. 1010, ¶¶0004–0024, 0088–0092, FIGs. 1–3, 13.) This solution to the well-known desire to reduce size, cost, and other known benefits was well described in the art by the time of the alleged inventions. (*Id.*)



(Ex. 1010, FIG. 13 (illustrating the comparative size reduction for image sensor packages using through-wafer vias).)

112. Notably, while Wood describes electrical connections for semiconductor dies having wire bonds 32, conductors 28, and external connectors 36 that extend around the outer surface of a semiconductor chip (similar to that of Ma), Wood also discloses, as a known alternative, the use of vias 29 extending from and connected to bond pads 26 to terminal pads 36' on the back side 24 of the die. (Ex. 1008, ¶¶0045, 0077, FIGs. 2, 10.) Specifically, as illustrated in Figure 10 of Wood (below), Wood discloses bond pads 26 (*i.e.*, a plurality of first conducting pads) arranged around an optically active region 11 (*i.e.*, a light-sensing area) and electrically connected to an imager array (*i.e.*, light-sensing elements) of an image

sensor. (Ex. 1008, ¶¶0005, 0015, 0019, 0021, 0024, 0044–0045, 0076–0077, FIGs. 2, 10.)



(Ex. 1008, FIG. 10)

113. Wood also discloses vias 29/terminal pads 36'/redistribution layer (*i.e.*, conducting channels) passing through the semiconductor die 20 (*i.e.*, chip) and electrically connected to bond pads 26 (*i.e.*, the first conducting pads) at one end as well as extending along with a second surface 24 of the semiconductor die 20. (Ex. 1008, ¶¶0005, 0015, 0019, 0021, 0024, 0044–0045, 0076–0077, FIGs. 2, 10; *see also* Ex. 1009, ¶¶0005–0012, 0094–0101, FIG. 14; Ex. 1010, ¶¶0053–0054, 0088–0092, FIGs. 5, 13.) Thus, Wood discloses all the features of limitations 1(c) and 1(d).

114. Accordingly, in light of the known demands for a semiconductor image sensor package of small size and low cost and the recognized suitability of a though-

wafer technique for electrical connections to assist in meeting those demands, a POSITA would have been motivated to configure Ma's redistribution structures using a through-wafer via technique as taught by Wood and others. As evidenced by Wood (and Imaoka and others), employing such a technique would have been within the POSITA and provided a reasonable expectation of success. (Ex. 1008, ¶¶0005, 0015, 0019, 0021, 0024, 0044–0045, 0076–0077, FIGs. 2, 10.)

e. a frame layer arranged on and in direct surface contact with the first electrodes and the insulation layer to form a cavity together with the bottom base

115. Ma discloses this limitation. For instance, Ma discloses a camera module 500 having, for example, lens assembly 302 (*i.e.*, a holder) (which optionally may be combined with spacing structure 122 in the FIG. 7 embodiment) having open space (*i.e.*, a through hole) for retaining a lens 304 and a contact surface on a bottom of the holder (*e.g.*, the bottom of lens assembly 302 or spacing structure 122 depending on the embodiment). (See, *e.g.*, Ex. 1007, ¶¶0039–0041 (describing a cavity above image sensing device 107), 0044–0047 (describing attachment of spacing structure 122 to semiconductor substrate 102), 0058–0061, 0072, FIGs. 4, 7 (below), and 9.)

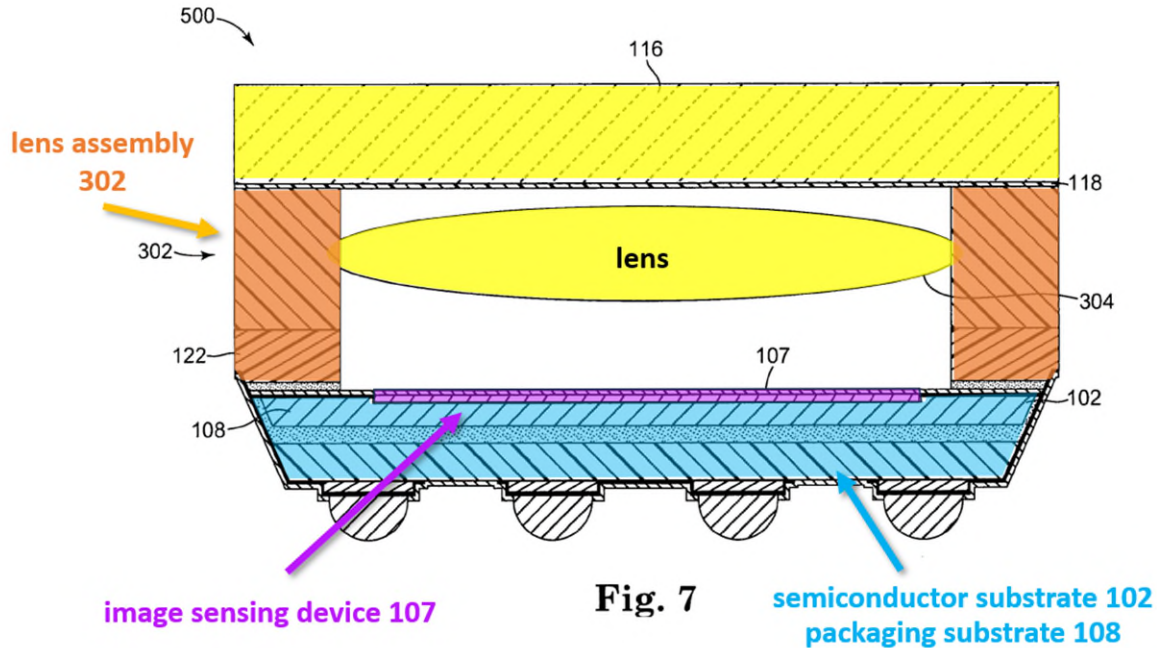


Fig. 7

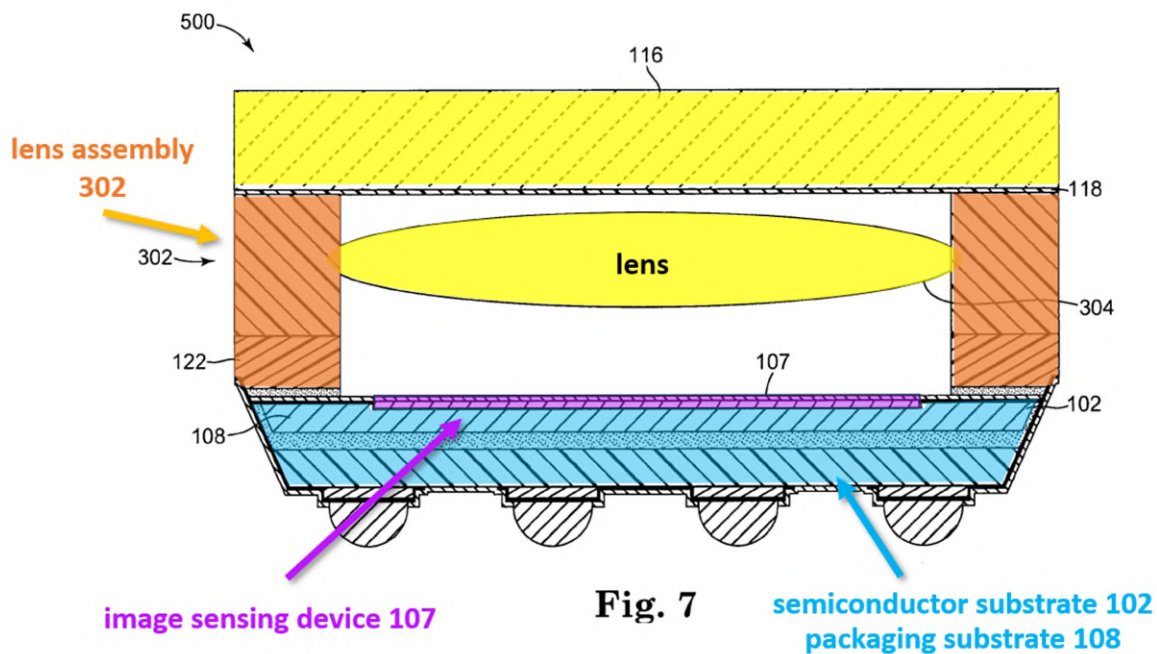
(Ex. 1007, FIG. 7.)

116. Ma discloses that camera module 500 is a variation on camera module 300, which in turn includes imaging module 100 to which a lens assembly 302 is attached. (See Ex. 1008, ¶¶0058, 0072.) Ma also discloses embodiments (FIGs. 4, 8, and 9) with similar lens support 252 in camera module 250 or lens assemblies 302i in camera modules 600 and 650 having through-holes and contact surfaces much like that shown in Figure 7.

f. wherein the contact surface is combined with the first surface

117. Ma discloses this limitation. For instance, as illustrated in Figure 7, Ma shows that a bottom surface of lens assembly 302/spacing structure 122 is combined with substrate 102. (See, e.g., Ex. 1007, 0044 (“Spacing structure 122 is attached to

semiconductor substrate 102 with an adhesive layer 124”), 0045–0047 (describing attachment of spacer 122 to semiconductor substrate 102), 0058–0061, 0072, FIGs. 4, 7 (below), 9.)



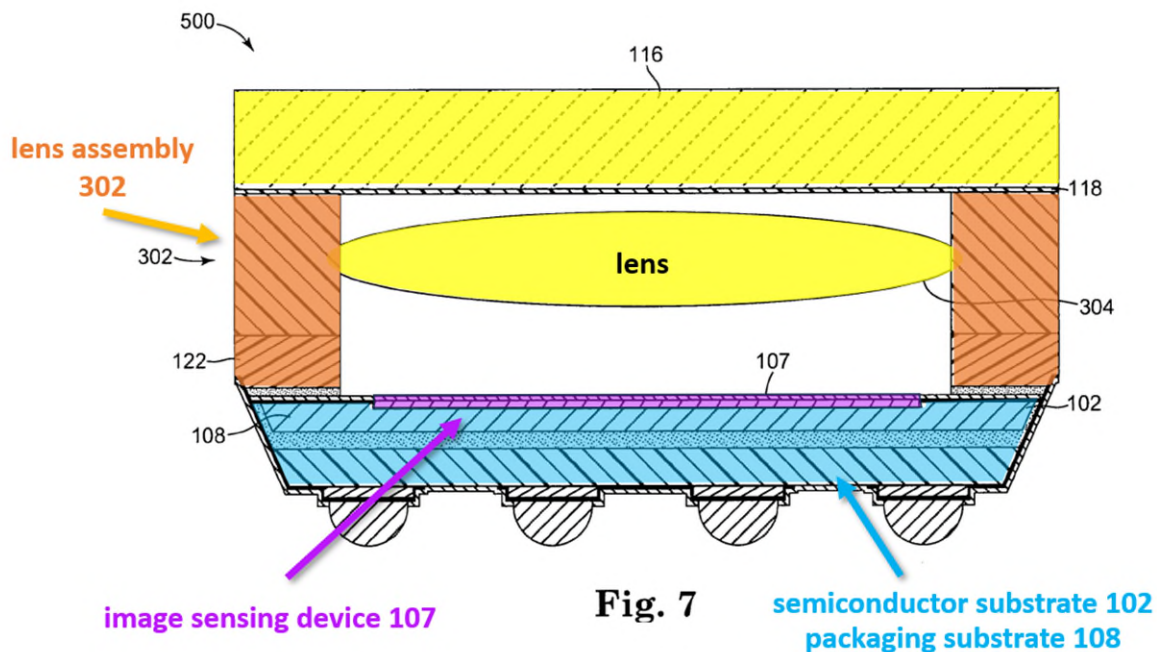
(Ex. 1007, FIG. 7.)

118. Ma also discloses additional embodiments (FIGs. 4, 8, and 9) that have a bottom surface of lens support 252 or lens assembly 302i combined with substrate 102 (via spacer 122) and function as lens holders combined with the top surface of the semiconductor substrate. (Ex. 1007, ¶¶0044, 0054–0055, 0072–0075.)

g. at least one lens completely embedded inside the through hole and integrated with the holder

119. Ma discloses this limitation. For instance, Ma illustrates a lens 304 completely embedded inside the through-hole and integrated with the lens assembly

302/spacing structure 122, as shown in Figure 7 below. (See, e.g., Ex. 1007, ¶¶0058 (“Lens assembly 302 includes a spacing structure 303 coupled to a lens 304.”), 0063 (explaining that according to one embodiment the lens assembly may be a single molded piece combining the lens and the spacing structure), 0072, FIG. 7 (below).



(Ex. 1007, FIG. 7.)

120. Ma also discloses additional embodiments (FIGs. 4, 8, and 9) with a lens 254 or 304i completely embedded inside the through hole and combined with their respective lens supports. (Ex. 1007, ¶¶0056, 0072–0075.)

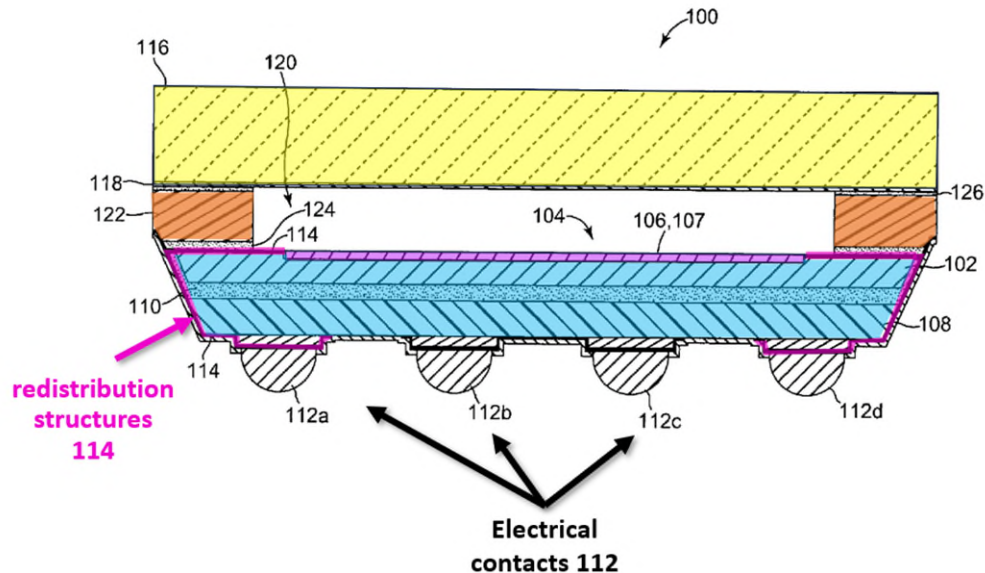
2. Claim 2 – The image sensor structure as claimed in claim 1, wherein the chip is a complementary metal oxide semiconductor (CMOS) image sensor chip

121. Ma discloses this limitation. For instance, Ma discloses the image sensor device 107 may be “a CMOS technology image sensor.” (Ex. 1007, ¶0031.)

A POSITA would have understood “CMOS technology image sensor” to refer to a complementary metal oxide semiconductor (CMOS) image sensor. (See Ex. 1006, ¶0026 (“Here, the image sensor 240 may be a suitable Charge Coupled Device (CCD) or a Complementary Metal-Oxide-Semiconductor (CMOS) image sensor.”).)

3. **Claim 3 – The image sensor structure as claimed in claim 1, wherein the chip further comprises a plurality of second conducting pads or balls which are arranged on the second surface of the chip and electrically connected to the conducting channel**

122. The Ma-Wood combination discloses and/or suggests this limitation. For instance, Ma discloses that the image sensor module employs redistribution structures 114 connected to connecting electrical contacts 112. (Ex. 1007, ¶0034, FIGs. 1, 4, 7–9.) This is illustrated in Figure 1 (below). In addition, Ma discloses the electrical contacts 112 may include a plurality of solder bumps “situated in a standard ball grid array (BGA) configuration.” (*Id.*)



(Ex. 1007, FIG. 1.)

123. Similarly, Wood discloses that terminal pads 36' may be formed over the conductive vias 29 on the back side 24 of the semiconductor die 20. (Ex. 1008, ¶0045.) And if desired “conductive bumps” may be formed on the terminal pads 36', as known in the art, including a ball-grid array. (Ex. 1008, ¶¶0045, 0067, 0078, FIGs. 2, 10.)

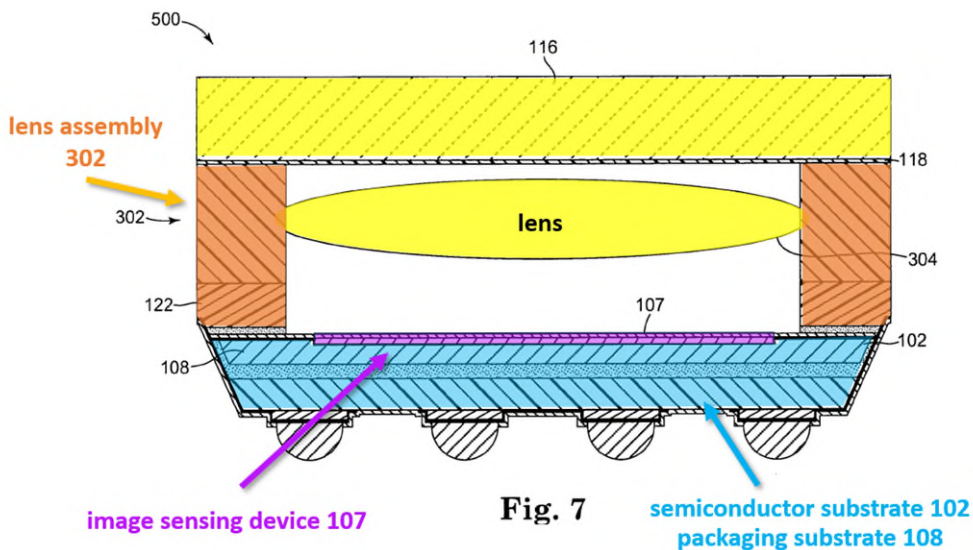
124. Thus, whether considering Ma's disclosure alone or in combination with Wood, Ma-Wood combination (*e.g.*, implementing Ma's redistribution structures as contact pads connected to conductive vias extending to traces on the back side of a semiconductor die) suggests chip further comprises a plurality of second conducting pads or balls which are arranged on the second surface of the chip and electrically connected to the conducting channel as disclosed by Ma and Wood.

4. **Claim 4 – The image sensor structure as claimed in claim 1, wherein the chip further comprises a ball grid array which is arranged on the second surface of the chip and electrically connected to the conducting channel**

125. The Ma-Wood combination discloses and/or suggests this limitation for the same reasons as discussed regarding claim 3. (Ex. 1007, ¶0034.)

5. **Claim 5 – The image sensor structure as claimed in claim 1, wherein a cavity is formed at the bottom of the holder**

126. Ma discloses this limitation. For instance, Ma discloses a cavity (*e.g.*, cavity 120, 220) is formed at the bottom of the spacing structures (*e.g.*, spacing structure 122 or inner lens assembly 302). (*See, e.g.*, Ex. 1007, ¶¶0039–0041, 0051, 0072, FIGs. 1, 3A, 4, 5A, 7–9.)



(Ex. 1007, FIG. 7.)

6. Claim 6 – The image sensor structure as claimed in claim 1, wherein the holder is made of a plastic material or a metal material

127. Ma discloses this limitation. For instance, Ma discloses that “[i]t will be understood by one skilled in the art that spacing structure 122 can be formed from a variety of moldable and/or machinable materials suitable for wafer level packaging.” (Ex. 1007, ¶0043.) In particular, spacing structure 122 may be formed from plastic. (*Id.*) Further, “[s]imilarly to transparent enclosure portion 116,” transparent enclosure portion 216, which functions as a lens support, “can be formed from a variety of suitable materials,” including high-temperature plastic. (Ex. 1007, ¶0052.) In addition, lens support 305, which is part of lens assembly 302, may be formed from plastic. (Ex. 1007, ¶0058.) And finally, outer lens assembly 302o may also be formed from plastic material. (Ex. 1007, ¶0074.) Accordingly, a POSITA would have understood Ma to disclose the lens assemblies may be made from plastic.

128. A POSITA would have been motivated to select a suitable material for the lens assembly. In light of a POSITA’s knowledge of suitable materials and as exemplified by Ma, a POSITA would have been motivated to configure the Ma-Wood camera module to include a lens assembly with an appropriate material, such as plastic. Furthermore, such a modification would have allowed the lens to be formed with known materials using known technologies/techniques (as

demonstrated by Ma) leading to a reasonable expectation of success. (See my reasoning and discussion regarding claim 6 with respect to Ground 1.)

7. Claim 7 – The image sensor structure as claimed in claim 1, wherein the contact surface is combined with the first surface by an adhesive.

129. Ma discloses this limitation. For instance, Ma discloses that the bottom surface the various lens holder structures can be combined with an adhesive, such as adhesive layers 124, 256, 306. (Ex. 1007, ¶¶0044, 0047, 0055, 0059, 0073.)

8. Claim 9 – The image sensor structure as claimed in claim 1, wherein the lens is a plastic lens.

130. Ma discloses this limitation. For instance, Ma teaches that lens 217, 304 and inner lens 304i may be made from plastic. (Ex. 1007, ¶¶0052, 0058, 0073, 0074.) Thus, Ma teaches that plastic is a suitable material for the lenses. Hence, a POSITA would appreciate that Ma discloses that a lens in the camera module may be a plastic lens for any of the embodiments described.

131. Further, POSITA would have been motivated to select a suitable material for the lens. In light of Ma and a POSITA's knowledge of suitable materials and as exemplified by Ma, a POSITA would have been motivated to configure the Ma-Wood camera module to include one or more lenses with an appropriate material, such as plastic. Furthermore, such a modification would have allowed the lens to be formed with known materials using known technologies/techniques (as

demonstrated by Ma) leading to a reasonable expectation of success. (See my analysis and discussion regarding claim 9 with respect to Ground I.)

9. Claim 10 – The image sensor structure as claimed in claim 9, which further comprises an IR cut filter glass which is embedded in the through hole and arranged below the plastic lens.

132. Ma combination discloses this limitation. For instance, Ma discloses optical filter film 118 may be a reflective infrared (IR) filter deposited on transparent enclosure portion 116. (Ex. 1007, ¶0036.) Ma further discloses that transparent enclosure portion 116 may be formed from glass. (Ex. 1007, ¶0035.) And as shown at least in Figures 4, 8, 9, transparent enclosure portion 116 may be embedded in the through-hole of the lens assembly and arranged below a plastic lens, as I discussed above regarding claim 9.

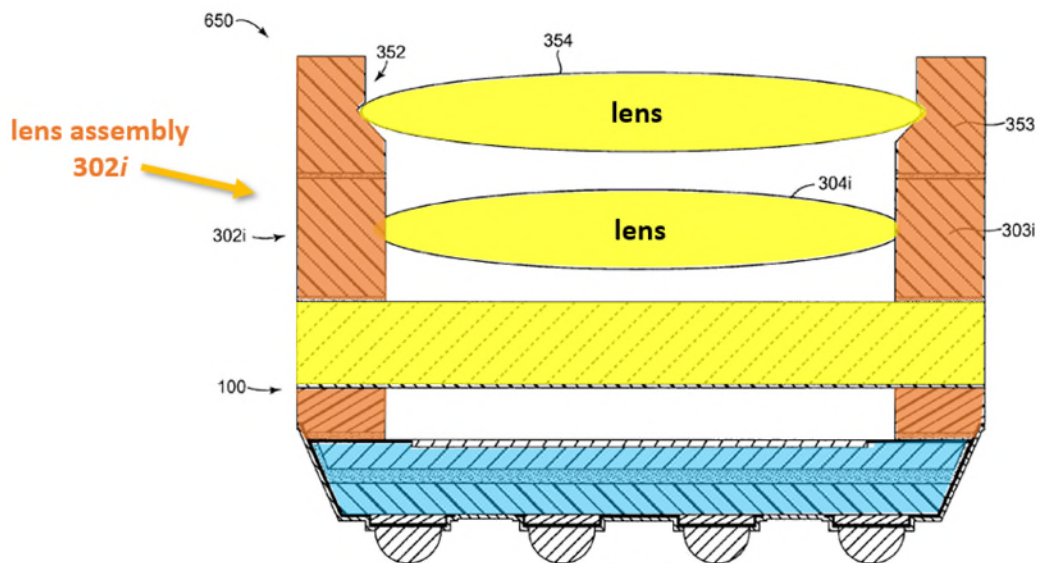


Fig. 9

(Ex. 1007, FIG. 9.)

133. Further, a POSITA would have been motivated to select a suitable material for the IR cut filter. In light of Ma and a POSITA's knowledge of suitable materials and as exemplified by Ma, a POSITA would have been motivated to configure the Ma-Wood camera module to include made from an appropriate materials. Furthermore, such a modification would have allowed the lens to be formed with known materials using known technologies/techniques (as demonstrated by Ma) leading to a reasonable expectation of success. (See my analysis and discussion regarding claim 10 with respect to Ground I.)

10. Claim 11 – The image sensor structure as claimed in claim 1, wherein the lens is a glass lens.

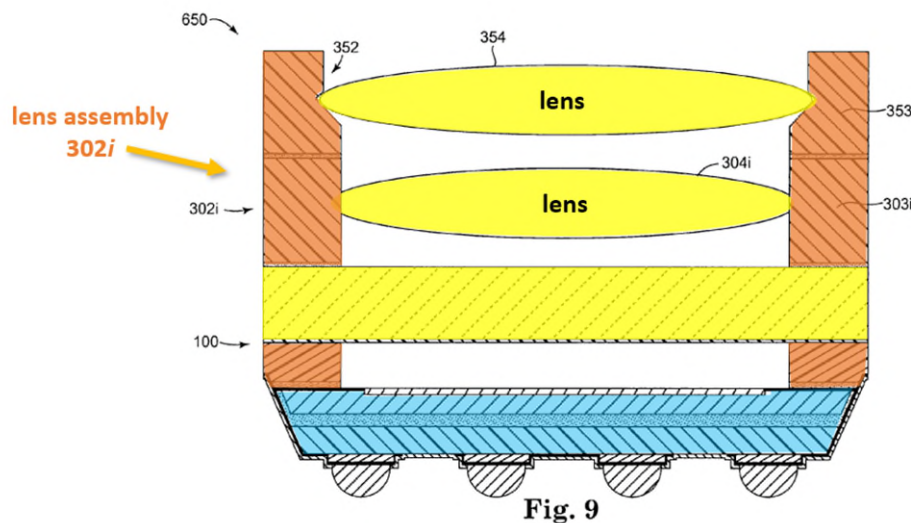
134. Ma discloses this limitation. Ma teaches that lens 217 and lens 304 may be made from glass. (Ex. 1007, ¶¶0052, 0058.) Thus, a POSITA would appreciate that Ma discloses the lens may be a glass lens for any of the embodiments described because glass was disclosed as a suitable material for a lens.

135. Further, a POSITA would have been motivated to select a suitable material for the lens. In light of Ma and a POSITA's knowledge of suitable materials and as exemplified by Ma, a POSITA would have been motivated to configure the Ma-Wood camera module to include one or more lenses with an appropriate material, such as glass. Furthermore, such a modification would have allowed the lens to be formed with known materials using known technologies/techniques (as

demonstrated by Ma) leading to a reasonable expectation of success. (See my analysis and discussion regarding claim 11 with respect to Ground I.)

11. Claim 13 – The image sensor structure as claimed in claim 1, wherein the lens comprises a glass lens and a plastic lens, wherein the glass lens is arranged below the plastic lens

136. The Ma disclose/suggests this feature. Ma discloses a dual lens camera modules 600, 650, including one lens 304i arranged below a second lens 304o or lens 354, respectively. (Ex. 1007, ¶¶0073–0074, FIGs. 8 and 9.)



(Ex. 1007, FIG. 9.)

137. As discussed above, Ma discloses that both glass and plastic were suitable materials for the lenses. (See my discussions and analysis of claims 9 and 11 above.) Further, camera modules typically utilized more than one lens to correct for optical aberration inherent in optical lenses, such as chromatic aberrations, astigmatism, field distortion, and others. (See my discussion and analysis of claims

13 in Ground I.) As discussed above, the choice of materials for such lens systems was routine part of optical design. Material selection would depend on the particular desired characteristics of the lens individually (*e.g.*, lighter weight or higher durability) or as a system (*e.g.*, aberrations created by a lens of one material may be compensated for by a lens of a different material) and their known tradeoffs, such as cost and availability. For example, Seo teaches that first and second lenses 140 and 180 “may be made of any suitable glass, plastic, or other optical quality material” for use within an image sensor camera module. (Ex. 1006, ¶0024.) Hence, a POSITA would have envisioned suitable two-lens arrangements, such as a glass lens and a plastic lens, including where the glass lens is arranged below the plastic lens.

138. In light of Ma and a POSITA’s knowledge of suitable materials, a POSITA would have been motivated to configure the Ma-Wood camera module to include two lenses with an appropriate material, such as glass and plastic, including herein the glass lens is arranged below the plastic lens. Furthermore, such a modification would have allowed the lens to be formed with known materials using known technologies/techniques (as demonstrated by Ma and Seo) leading to a reasonable expectation of success.

12. Claim 15 – The image sensor structure as claimed in claim 13, which further comprises an IR cut filter glass which is embedded in the through hole and arranged below the plastic lens

139. The Ma discloses/suggests this limitation for the same reasons as I discussed above regarding claims 9–11 and 13. As illustrated in the embodiment of Ma's Figure 9, an IR cut filter is placed in a through hole below two lenses.

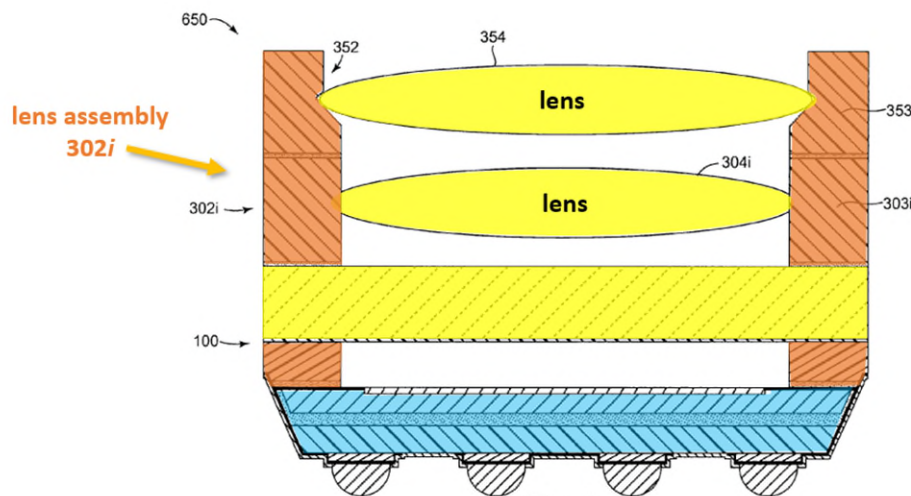


Fig. 9

(Ex. 1007, FIG. 9.)

140. Further, as previously discussed, Ma teaches suitable materials for the lenses (plastic and glass) and for the IR filter (glass). In light of Ma and a POSITA's knowledge of suitable materials, a POSITA would have been motivated to configure the Ma-Wood camera module to include two lenses with an appropriate material, such as glass and plastic, including herein the glass lens is arranged below the plastic lens. Likewise a POSITA would have been motivated to configure the Ma-Wood camera module to an IR cut filter made from an appropriate material such as glass.

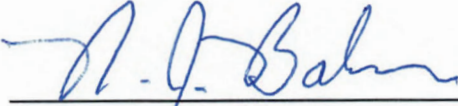
Furthermore, such a modification would have allowed the lens to be formed with known materials using known technologies/techniques (as demonstrated by Ma and Seo) leading to a reasonable expectation of success. (*See* also my analysis and discussion regarding claims 9–11 and 13.)

VIII. CONCLUSION

141. My opinions are based upon the information that I have considered to date. I am unaware of any evidence of secondary considerations with respect to the '602 patent that would render any of the asserted claims non-obvious. I reserve the right, however, to supplement my opinions in the future to respond to any arguments raised by the owner of the '602 patent and to consider new information that becomes available to me.

142. I declare that all statements made herein of my knowledge are true, and that all statements made on information and belief are believed to be true, and 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.

By:


R. Jacob Baker, Ph.D., P.E.

Date:

