Appeal Decision

Appeal No. 2020-3426

Appellant THE BOEING COMPANY

Patent Attorney Sonoda & Kobayashi Intellectual Property Law

The case of appeal against the examiner's decision of refusal of Japanese Patent Application No. 2014-120223, entitled "SYSTEMS AND METHODS FOR DRY ETCHING A PHOTODETECTOR ARRAY" (application published on January 5, 2015, Japanese Unexamined Patent Application Publication No. 2015-2348) has resulted in the following appeal decision.

Conclusion

The appeal of the case was groundless.

Reason

No. 1 History of the procedures

The present application is an application on June 11, 2014 (priority claim under the Paris Convention: June 17, 2013, USA), and the history of the procedures is as follows.

May 28, 2018: Notification of reasons for refusal

December 5, 2018: Submission of a written opinion and a written amendment (hereinafter, the amendments made in this written amendment are referred to as "Amendment 1").

March 26, 2019: Notification of reasons for refusal (final)

July 2, 2019: Submission of a written opinion and a written amendment (hereinafter, the amendments made in this written amendment are referred to as "Amendment 2").

October 31, 2019: Decision to dismiss Amendment 2 (hereinafter referred to as "the decision of dismissal") and decision of refusal

March 12, 2020: Submission of a written request for appeal

September 30, 2020: Inquiry by the body

March 5, 2021: Submission of response

No. 2 Propriety of the decision of dismissal

Since the appellant has made an appeal against the decision of dismissal, the propriety of the decision of dismissal will be judged below.

1. Outline of reasons for the decision of dismissal

By the amendments to [0016], [0017], and [0019] in the specification attached to the application of the present application made in Amendment 2, in the specification, scope of claims, or drawings originally attached to the application of the present application (hereinafter referred to as "the original specification, etc."), the description of using $BrCl_3$ and Ar and the description of using BCl_3 and Ar, which are mixed in the dry etching, are unified as the description of using $BrCl_3$ and Ar.

However, an amendment to eliminate inconsistent descriptions is allowed "when" which of the two or more inconsistent descriptions is correct "is obvious for a person skilled in the art based on the description in the original specification, etc.", but both $BrCl_3$ and BCl_3 are compounds with a known chemical formula, and $BrCl_3$ and BCl_3 appear in the same number of times in the original specification, etc., and therefore, it cannot be said that which is correct is obvious based on the description in the original specification, etc.

Therefore, since the above-mentioned amendment is not made within the scope of the matters described in the original specification, etc., Amendment 2 violates the provisions of the Patent Act Article 17-2(3).

Accordingly, Amendment 2 should be dismissed under the provisions of the Patent Act Article 53(1).

2. Contents of Amendment 2

Regarding Claim 1 and [0005], [0006], [0016], [0017], [0019], [0022], [0028], [0038], and [0044] in the specification, scope of claims, or drawings attached to the application of the present application before Amendment 2, the substance used with Ar is amended from "BCl_3" to "$BrCl_3$" by Amendment 2.

3. Description of the original specification, etc.

The following contents are described in the original specification, etc.

(1) "[SCOPE OF CLAIMS]"

"A photodetector array (100) for use in imaging, the photodetector array comprising: a first photodetector formed from InAsSb; a second photodetector formed from InAsSb; and a trench (200) formed between the first photodetector and the second

photodetector by using $BrCl_3$ and Ar." ([Claim 1])

"A method for fabricating an array of photodetectors, the method comprising: receiving a pattern (302) of an array of the photodetectors formed from InAsSb, the pattern including at least one trench (200) defined between adjacent photodetectors; and dry etching the at least one trench with plasma containing $BrCl_3$ and Ar." ([Claim 7])

(2) "[TECHNICAL FIELD]"

"The field of the present disclosure relates generally to dry etching, and more specifically, to methods and systems for dry etching of photodetectors." ([0001])

(3) "[BACKGROUND]"

"Generally, photodetectors are used in a variety of camera systems to detect light. The photodetectors include a set of sensors or a focal plane array (FPA) that is formed by a set of sensors electrically insulated from one another. One form of insulating the sensors from one another is through etching in which material is removed to create trenches between sensors. A wet etching process is an isotropic process whereby a solution (e.g., acid or base solution) is used to remove material. A dry etching process is an anisotropic process in which the material is removed after exposure to plasma. In some known wet etching processes, the acid solution etches laterally in the trenches leading to a reduction in optical response per pixel (i.e., loss of fill factor). In some known dry etching processes, organic compounds reducing optical response per pixel or increasing the dark current are formed during deep etchings, and low sensitivity images are provided." ([0002])

"Therefore, it is necessary to develop an etching method that does not reduce optical response per pixel at the time of implementation." ([0003])

(4) "[SUMMARY]"

"In one aspect, a method for fabricating an array of photodetectors is provided. The method includes receiving a pattern of an array of photodetectors formed from InAsSb, the pattern including at least one trench defined between adjacent photodetectors, and dry etching the at least one trench with plasma containing $BrCl_3$ and Ar." ([0004])

"In another aspect, a method of imaging using a photodetector array is provided. The method includes providing a photodetector array and receiving wavelengths by a first photodetector of the photodetector array and a second photodetector of the photodetector array, and a trench is formed between the first photodetector and the second photodetector and the trench is formed by dry etching using $BrCl_3$ and Ar." ([0005])

"In yet another aspect, a photodetector array for use in imaging is provided. The

photodetector array includes a first photodetector formed from InAsSb, a second photodetector formed from InAsSb, and a trench formed between the first photodetector and the second photodetector, and the trench is formed using $BrCl_3$ and Ar." ([0006])

(5) "[DETAILED DESCRIPTION]"

"The systems and methods described herein enable dry etching of photodetectors based on InAsSb. As used herein, the term 'dry etching' or 'etching' refers to the removal of material by exposure to ions or plasma of reactive gases that displaces or dislodges the material." ([0009])

"FIG. 1 is a perspective view of an exemplary photodetector array 100. In an exemplary embodiment, the photodetector array 100 includes an array of photodetectors or sensors 102 formed on a semiconductor substrate. The sensors 102 are separated by trenches 104 formed by a dry etching process. In one embodiment, the photodetector 100 includes 16 sensors that are 27 um wide. Alternatively, the photodetector array 100 may include any number of sensors having any size and shape that facilitates imaging as described herein. The sensors 102 are formed from a material including InAsSb and may be configured to operate in a dual band capacity such that the sensors 102 detect two wavelengths. In one embodiment, the photodetector array 100 is configured to be incorporated into an infrared imaging device." ([0010])

"FIG. 2 is a perspective view of a trench 200 that may be used in the photodetector array 100 shown in FIG. 1 and FIG. 3 is an alternate perspective view of the trench 200 shown in FIG. 2. In an exemplary embodiment, the trench 200 is a void created in a photodetector array, such as the photodetector array 100. The trench 200 is created by etching away the material in the photodetector array 100. In one embodiment, the trench 200 etches or removes the first light-absorbing layer 204, barrier layer 206, and the second light-absorbing layer 208 to form separate mesas 207 and 209 including the layers 204, 206, and 208. The first light-absorbing layer 204 and the second light-absorbing layer 208 include InAsSb." ([0011])

"In an exemplary embodiment, the material of the photodetector array 100, including, but not limited to, the layers 204, 206, and 208, is etched away to form the trench 200 defined at least partially by a first side wall 210, a second side wall 212, and a base 214 and extending between the first side wall 210 and the second side wall 212. In one embodiment, the trench 200 has a height of 6 um and a width of 6.5 um. The side walls 210 and 212 are smoothly vertical such that the trench 200 is formed in a "U" shape. Alternatively, the trench 200 may have any size or shape that facilitates imaging as described herein. In an exemplary embodiment, the trench 200 is sized and shaped such

that adjacent photodetectors or sensors are electrically insulated from one another." ([0012])

"The trench 200 is formed such that the side walls 210 and 212 do not undercut a dielectric mask 202. That is, the trench 200 is formed such that the distance 214 extending between the mask 202 and the trench centerline 216 is at least equal to or larger than any distance between the side wall 210 and the centerline 216, such as the distance 218. Similarly, the distance 220 extending between the mask 202 and the trench centerline 216 is at least equal to or larger than any distance between the side wall 212 and the centerline 216, such as the distance 222." ([0013])

"FIG. 4 is a flowchart 300 of an exemplary method for dry etching the trench 200 shown in FIGS. 2 and 3. In an exemplary embodiment, a pattern of an array of photodetectors formed from InAsSb is accepted 302. The accepted pattern 302 includes a plurality of trenches, such as the trench 200 shown in FIG. 2, separating adjacent photodetectors. In one embodiment, the trenches are 1-5 um wide. Alternatively, the trenches can be in any amount and have a size that facilitates imaging as described herein." ([0014])

"In one embodiment, the accepted pattern 302 includes depositing a dielectric hard mask on the InAsSb using plasma-enhanced chemical vapor deposition (PECVD). In one embodiment, the hard mask includes SiO_2 and is deposited at 175° C. Alternatively, the hard mask can be deposited with any material at any temperature. Photolithography is performed on the hard mask to define the pattern of the array of photodetectors and the hard mask is etched. In one embodiment, the hard mask is etched using a CF_4 plasma. Once the pattern is transferred into the hard mask, the photoresist is removed. In one embodiment, the photoresist is removed using an AZ400T stripper and ultrasound. Alternatively, the photoresist can be removed in any fashion that facilitates forming trenches as described herein. The InAsSb including the pattern in the hard mask is grease mounted to a carrier for dry etching. In one embodiment, the carrier is a 4-inch silicone (Si) carrier." ([0015])

"In an exemplary embodiment, after the pattern of an array of photodetectors formed from InAsSb is accepted 302, the photodetectors are placed 304 in a vacuum chamber in order to perform dry etching of trenches within the accepted pattern 302. Plasma gas is introduced 306 into the vacuum to etch the trenches. In one embodiment, the plasma includes BCl_3 and Ar. In some embodiments, BCl_3 in the range of 1-100 sccm is used and Ar in the range of 1-100 sccm is used. Alternatively, any amount of BCl_3 and Ar can be used that facilitates etching as described herein. Before etching of the trenches occurs, the plasma is ionized 306 such that the ions become reactive. In some

embodiments, the plasma is ionized 306 using an RF signal. Alternatively, the plasma can be ionized in any manner that facilitates etching as described herein." ([0016])

"After the plasma is ionized 306, the plasma is accelerated 310 such that the material is etched away. In an exemplary embodiment, BCl_3 reacts with the In, Ga, Al, As and Sb atoms to form Cl compounds. The Ar ions are configured to mechanically sputter the chemical etching products (e.g., Cl compounds) to cause desorption of the chemical etching products. In one embodiment, the Ar ions also chemically etch a portion of the trenches in addition to BCl_3. The use of BCl_3 and Ar enables etching to occur that results in photodetectors having smooth side walls and preventing undercutting of the photodetectors." ([0015])

"In some embodiments, etching of the trenches is adjusted 312. In one embodiment, the rate of etching is adjusted by adjusting the bias power and/or pressure. The bias power controls the momentum of the ions and the pressure affects the speed of the ions by changing their mean free path. As such, the bias power and/or pressure affects the rate of etching. In an exemplary embodiment, the bias voltage is in the range of 10-300V and a pressure is in the range of 1-20 mT. Alternatively, the bias power can be any voltage and the pressure can be any pressure that facilitates etching as described herein. In one embodiment, the pressure is increased to improve the morphology at the bottom of the mesas of the photodetectors and the pressure is decreased to improve the morphology at the top of the mesas of the photodetectors. As used herein, the 'morphology' refers to at least one of a verticality and roughness of the surface of the mesa. As used herein, the 'roughness' refers to the deviation of the surface from a flat plane. In some implementations, 'roughness' or a 'rough surface' includes a surface having one or more cracks, protrusions, or holes. Similarly, 'smooth' or 'smoothness' refers to a surface that is devoid of imperfections (e.g., cracks, protrusions, or holes) and is free of roughness. Accordingly, in some implementations, improving the morphology may include altering at least one of the verticality and the roughness of the surface of the mesa." ([0018])

"In some embodiments, etching is adjusted 312 by changing the ICP power. Increasing the ICP power improves the morphology at the bottom of the side walls of the photodetectors. Similarly, the gas ratio of the plasma used for etching may also be adjusted to improve the morphology of the side walls. In one embodiment, the proportion of Ar to BCl_3 is increased to achieve smooth etching on side walls of the photodetectors. In an exemplary embodiment, the ICP power used for etching is in the range of 100-1200 W. Alternatively, any ICP power and gas ratio can be used that facilitate etching as described herein. In one embodiment, the temperature is adjusted to change or determine the slope of side walls of the photodetectors. As the temperature within the vacuum is

increased, the side walls of the photodetectors become more vertical. It should be noted that trenches are created between photodetectors such that no undercutting of the photodetectors occurs." ([0018])

"According to one aspect of the present disclosure, the photodetector array 100 is provided for use in imaging, and the photodetector array includes a first photodetector formed from InAsSb, a second photodetector formed from InAsSb, and a trench 200 formed between the first photodetector and the second photodetector, and in addition, the trench is formed using $BrCl_3$ and Ar." ([0022])

"According to one aspect of the present disclosure, the method for fabricating an array of photodetectors is provided, and the method includes receiving the pattern 302 of the array of photodetectors formed from InAsSb, the pattern including at least one trench 200 defined between adjacent photodetectors, and dry etching at least one trench with plasma containing $BrCl_3$ and Ar." ([0028])

"According to one aspect of the present disclosure, the method of imaging using the photodetector array is provided, and the method includes providing the photodetector array and receiving wavelengths by the first photodetector of the photodetector array and the second photodetector of the photodetector array, and in addition, a trench 200 is formed between the first photodetector and the second photodetector and the trench 200 is formed by dry etching using $BrCl_3$ and Ar." ([0038])

"As compared with at least some known etching systems, the systems and methods described herein enable dry etching of trenches within the photodetector array to prevent and/or eliminate undercutting of photodetectors. Forming trenches that do not undercut photodetectors prevents deformation of optical response per pixel, which provides more highly sensitive images. The systems and methods described herein also enable creating trenches that electrically insulate adjacent photodetectors and leaving the photodetectors with smoothly vertical side walls while preserving the electrical performance. A low-bias operation of large area devices is also achieved using the methods and systems described herein." ([0042])

4. Judgment by the body

(1) An amendment to the specification, scope of claims, or drawings must be made within the scope of the matters described in the specification, scope of claims, or drawings originally attached to the application (Patent Act Article 17-2[3]), wherein the "matters described in the specification, scope of claims, or drawings" are technical matters derived by integrating all the descriptions in the specification, scope of claims, or drawings originally attached to the application for a person skilled in the art. When an amendment

does not introduce new technical matters in relation to the technical matters thus derived, it can be said that the amendment is made within the scope of the matters described in the specification, scope of claims, or drawings originally attached to the application.

(2) Recognition of the technical matters described in the original specification, etc.

According to the description in the original specification, etc., recognized in 3 above, it is recognized that the following technical matters are described in the original specification, etc.

A The field of the present disclosure relates generally to dry etching, and more specifically, to methods and systems for dry etching of photodetectors. ([0001])

B Generally, photodetectors are used in a variety of camera systems to detect light. The photodetectors include a set of sensors or a focal plane array that is formed by a set of sensors electrically insulated from one another. One form of insulating the sensors from one another is through etching in which material is removed to create trenches between sensors.

A wet etching process is an isotropic process, while a dry etching process is an anisotropic process, in which the material is removed after exposure to plasma. In some known wet etching processes, the acid solution etches laterally in the trenches leading to a reduction in optical response per pixel (i.e., loss of fill factor). In some known dry etching processes, organic compounds reducing optical response per pixel or increasing the dark current are formed during deep etchings, and low-sensitivity images are provided. Therefore, it is necessary to develop an etching method that does not reduce optical response per pixel at the time of implementation. ([0002] and [0003])

C The systems and methods described herein enable dry etching of photodetectors based on InAsSb. ([0009])

D The method for fabricating an array of photodetectors includes receiving a pattern of an array of photodetectors formed from InAsSb, the pattern including at least one trench defined between adjacent photodetectors, and dry etching at least one trench with plasma containing $BrCl_3$ and Ar.

The method of imaging using a photodetector array includes providing a photodetector array and receiving wavelengths by the first photodetector of the photodetector array and the second photodetector of the photodetector array, wherein a trench is formed between the first photodetector and the second photodetector, and the trench is formed by dry etching using $BrCl_3$ and Ar.

The photodetector array for use in imaging includes a first photodetector formed from InAsSb, a second photodetector formed from InAsSb, and a trench formed between

the first photodetector and the second photodetector, and the trench is formed using $BrCl_3$ and Ar. ([Claim 1], [Claim 7], and [0004]-[0006])

E The photodetectors are placed in a vacuum chamber in order to perform dry etching of trenches, and plasma gas is introduced into the vacuum to etch the trenches. In one embodiment, the plasma includes BCl_3 and Ar. In some embodiments, BCl_3 in the range of 1-100 sscm is used and Ar in the range of 1-100 sccm is used. Alternatively, any amount of BCl_3 and Ar can be used that facilitates etching. Before etching of the trenches occurs, the plasma is ionized such that the ions become reactive. After the plasma is ionized, the plasma is accelerated such that the material is etched away. In an exemplary embodiment, BCl_3 reacts with the In, Ga, Al, As and Sb atoms to form Cl compounds. The Ar ions are configured to mechanically sputter the chemical etching products (e.g., Cl compounds) to cause desorption of the chemical etching products. In one embodiment, the Ar ions also chemically etch a portion of the trenches in addition to BCl_3. The use of BCl_3 and Ar enables etching to occur that results in photodetectors having smooth side walls and preventing undercutting of the photodetectors. The gas ratio of the plasma used for etching may also be adjusted to improve the morphology of the side walls, and in one embodiment, the proportion of Ar to BCl_3 is increased to achieve smooth etching on side walls of the photodetectors. ([0016], [0017], and [0019])

F According to one aspect of the present disclosure, the photodetector array 100 is provided for use in imaging, and the photodetector array includes a first photodetector formed from InAsSb, a second photodetector formed from InAsSb, and a trench 200 formed between the first photodetector and the second photodetector, wherein the trench is formed using $BrCl_3$ and Ar.

According to one aspect of the present disclosure, the method for fabricating an array of photodetectors is provided, wherein the method includes receiving the pattern 302 of an array of photodetectors formed from InAsSb, the pattern including at least one trench 200 defined between adjacent photodetectors, and the method includes dry etching at least one trench with plasma containing $BrCl_3$ and Ar.

According to one aspect of the present disclosure, the method of imaging using a photodetector array is provided, and the method includes providing a photodetector array and receiving wavelengths by the first photodetector of the photodetector array and the second photodetector of the photodetector array, wherein a trench 200 is formed between the first photodetector and the second photodetector and the trench 200 is formed by dry etching using $BrCl_3$ and Ar. ([0022], [0028], and [0038])

G As compared with at least some known etching systems, the systems and methods described herein enable dry etching of trenches within a photodetector array to prevent

and/or eliminate undercutting of photodetectors. Forming trenches that do not undercut photodetectors prevents deformation of optical response per pixel, which provides higher sensitive images.

The systems and methods described herein also enable creating trenches that electrically insulate adjacent photodetectors and leaving the photodetectors with smoothly vertical side walls while preserving the electrical performance.

A low-bias operation of large area devices is also achieved using the methods and systems described herein. ([0042])

H Examples clarifying the specific conditions of the dry etching process are not described in the original specification, etc.

(3) Judgment

A According to the technical matters recognized in (2) above, it is recognized that both the technical matter of using plasma containing $BrCl_3$ and Ar in forming at least one trench defined between adjacent photodetectors by dry etching in a photodetector based on InAsSb (hereinafter referred to as "$BrCl_3$ technical matter". D and F in [2] above), and the technical matter of using plasma containing BCl_3 and Ar in such a case (hereinafter referred to as "BCl_3 technical matter". E in [2] above) are described in the original specification, etc.

Meanwhile, in the original specification, etc., the $BrCl_3$ technical matter (D in [2] above) is recited in the claims, etc., whereas the BCl_3 technical matter (E in [2] above) is described in the explanation of a technical principle of the invention described in the original specification, etc.

In addition, according to the description in the original specification, etc. ([1] above), the wording of "$BrCl_3$" relating to the $BrCl_3$ technical matter is described 8 times (Claim 1, Claim 7, [0004], [0005], [0006], [0022], [0028], and [0038]), and the wording of "BCl_3" relating to the BCl_3 technical matter is described 7 times ([0016], [0017], and [0019]), of which the numbers of times of being described are almost the same.

As described above, since there is a discrepancy between the recitation in the claims, etc., and the description in the explanation of the technical principle of the invention in the original specification, etc., it can be said that a person skilled in the art can recognize that not both two technical matters should be described in the original specification, etc., but one of them is incorrect. However, the numbers of times both technical matters are described are almost the same, and there is no description in the examples (H in [2] above), or there is no evidence showing common technical knowledge to clarify which of the two technical matters is correct and which is incorrect.

Thus, it can be said that it is unclear which of the two technical matters is correct and which is incorrect in the description of the original specification, etc.

B In addition, according to 2 above, by Amendment 2, all the descriptions relating to the BCl_3 technical matter are deleted, and only the $BrCl_3$ technical matter is described.

C According to A and B above, by Amendment 2, in the description of the original specification, etc., the matter that it is unclear which of the $BrCl_3$ technical matter and the BCl_3 technical matter is correct has been clarified as the $BrCl_3$ technical matter being correct.

Therefore, it should not be said that Amendment 2 does not introduce new technical matters in relation to the technical matters derived by integrating all the descriptions in the original specification, etc.

D In response to the above, the appellant alleges as follows, but none of the allegations can be adopted.

(A) The appellant alleges that considering the scope of claims (see U.S. Pat. No. 8,941,145) when U.S. Patent Application No. 13/919541, which is the basic application claiming right of priority of the present application, is patented, it is clear that the $BrCl_3$ technical matter is intended in the original specification, etc.

However, the material used to judge whether a new matter is added is the description in the original specification, etc., and the description in the US application when it is patented does not affect the judgment in C above.

(B) The appellant alleges that BCl_3 is one of the most commonly used gases for etching a compound semiconductor, whereas the focus of the invention according to the present application is actually on $BrCl_3$ being synthesized and used for etching, and an improved result being found as compared with BCl_3.

However, since there is no such description in the original specification, etc., the allegation of the appellant is not based on the description in the original specification, etc.

(C) The appellant alleges that since BCl_3 is one of the most commonly used gases for etching a compound semiconductor, $BrCl_3$ is justified in this respect as well.

However, the matter that BCl_3 is one of the most commonly used gases can rather be a circumstance that the BCl_3 technical matter is correct, and there is no evidence showing that the BCl_3 technical matter (that is, the technical matter of using plasma containing BCl_3 and Ar in forming at least one trench defined between adjacent photodetectors by dry etching in a photodetector based on InAsSb) is common technical knowledge, and therefore, it cannot be concluded that the $BrCl_3$ technical matter is correct

based on the circumstances alleged by the appellant.

E Therefore, Amendment 2 is not made within the scope of the matters described in the original specification, etc., and thus violates the provisions of the Patent Act Article 17-2(3).

5. Summary of the propriety of the decision of dismissal

As described above, the decision to dismiss Amendment 2 is legal.

No. 3 Judgment for the Invention

1. Recognition of the Invention

As described in No. 2 above, since the decision of dismissal is legal, it is recognized that the inventions according to the claims of the present application are as recited in the scope of claims amended in the written amendment submitted on December 5, 2018, and the invention according to Claim 1 (hereinafter referred to as "the Invention") is as follows.

"A method for fabricating an array of photodetectors, the method comprising:

providing an array of the photodetectors formed from InAsSb, which includes at least one trench (200) defined between adjacent photodetectors; and dry etching the at least one trench with plasma containing BCl_3 and Ar."

2. Outline of the reasons for refusal stated in the examiner's decision

In the examiner's decision, the present application was rejected for the reasons notified in the notification of reasons for refusal dated March 26, 2019, after Amendment 2 was dismissed, and the reasons include the following contents.

(1) The amendment made in the written amendment submitted on December 5, 2018 (Amendment 1) is not made within the scope of the matters described in the original specification, etc., and thus does not satisfy the requirement as provided in the Patent Act Article 17-2(3).

(2) The invention according to Claim 1 (the Invention) cannot be granted a patent under the provision of the Patent Act Article 29(2) for the reason that the Invention could have easily been made by a person skilled in the art on the basis of the inventions described in the following documents, which are distributed publications or made available to the public through electric telecommunication lines in Japan or other foreign countries before the priority date of the Invention.

<The list of cited documents>

1. Japanese Unexamined Patent Application Publication No. 2010-41011
2. National Publication of International Patent Application No. 2013-510442
3. National Publication of International Patent Application No. 2008-510303
4. Japanese Unexamined Patent Application Publication No. H9-171990
5. Japanese Unexamined Patent Application Publication No. H10-27783

3. Regarding the addition of a new matter by Amendment 1
(1) Contents of Amendment 1

Amendment 1 includes, in Claim 1, [0005], [0006], [0022], [0028], and [0038] of the original specification, etc., amending the substance used with Ar from “$BrCl_3$” to “BCl_3”, deleting Claim 7 (which specifies that the substance used with Ar is “$BrCl_3$”) in the original specification, etc., and in [0044] of the original specification, etc., adding a description of using “$BrCl_3$ and Ar.”

(2) Judgment

A As explained in 4(3)A of No. 2 above, it is unclear which of the $BrCl_3$ technical matter and the BCl_3 technical matter is correct and which is incorrect in the description of the original specification, etc. Meanwhile, according to (1) above, by Amendment 1, the BCl_3 technical matter is described in the specification, scope of claims, or drawings attached to the application of the present application except for the $BrCl_3$ technical matter described in [0004]. Thus, by Amendment 1, the discrepancy between the recitation in the claims, etc. and the description in the explanation of a technical principle of the invention, which exists in the original specification, etc. (4[3]A of No. 2 above) is resolved, and the wording of “BCl_3” relating to the BCl_3 technical matter is described 15 times (Claim 1. [0005], [0006], [0016], [0017], [0019], [0022], [0028], [0038], and [0044]), and the wording of “$BrCl_3$” relating to the $BrCl_3$ technical matter is described once ([0004]), of which the number of times of being described is significantly less than the that of the wording of “BCl_3”. In addition, there is no evidence showing common technical knowledge that the BCl_3 technical matter is incorrect.

Therefore, it can be said that, by Amendment 1, a person skilled in the art could have recognized that the description relating to the $BrCl_3$ technical matter is an error and the BCl_3 technical matter is correct.

C According to B above, it can be said that by Amendment 1, in the description of the original specification, etc., the matter that it is unclear which of the $BrCl_3$ technical matter and the BCl_3 technical matter is correct has been clarified as the BCl_3 technical

matter being correct.

Therefore, it should not be said that Amendment 1 does not introduce new technical matters in relation to the technical matters derived by integrating all the descriptions in the original specification, etc.

Accordingly, Amendment 1 is not made within the scope of the matters described in the original specification, etc., and thus violates the provisions of the Patent Act Article 17-2(3).

4. Regarding the lack of an inventive step

(1) Recognition of the inventions described in the cited documents

A The following contents are described in Japanese Unexamined Patent Application Publication No. 2010-41011 (hereinafter referred to as “Cited Document 1”) cited in the examiner’s decision (underlines are added by the body).

(A) “Hereinafter, a preferred embodiment of the present invention will be described in detail with reference to the drawings. In the description of the drawings, if possible, the same elements are represented by the same reference numerals, and duplication of description is avoided. FIG. 1 is a diagram showing a cross-sectional configuration of the photodetection device 1. The photodetection device 1 includes a compound semiconductor substrate 2 and a plurality of photodetection elements 4. The compound semiconductor substrate 2 is, for example, a semi-insulating GaAs substrate and has a thickness of about 0.3 to 1 mm. The plurality of photodetection elements 4 are provided on the main surface 2a of the compound semiconductor substrate 2. Each photodetection element 4 is an InSb compound semiconductor layer and has a thickness of about 1 to 5 μm. The plurality of photodetection elements 4 are separated (insulated) from one another by a separation groove 5, and are electrically connected in series via a plurality of electrodes 16. The length of the photodetection element 4 extending in a predetermined direction (the direction in which the plurality of photodetection elements 4 are connected in series) is about 5 to 20 μm, and the distance between two photodetection elements 4 adjacent to each other in this direction with a separation groove 5 interposed therebetween (a width of the separation groove 5) is about 1 to 3 μm. The photodetection element 4 has a first surface 4a and a second surface 4b, and the first surface 4a is bonded to the main surface 2a of the compound semiconductor substrate 2. The second surface 4b is on the opposite side of the first surface 4a. The main surface 2a and the first surface 4a are bonding surfaces between the compound semiconductor substrate 2 and the photodetection element 4, and the second surface 4b is the main surface of the

photodetection element 4.” ([0008])

[図1]	[FIG. 1]

“The photodetection element 4 includes a photodetection region 6, a first region 8, a second region 10, and a third region 12. The photodetection region 6 is embedded in the photodetection element 4. The photodetection region 6 is provided between the first surface 4a and the second surface 4b. The photodetection region 6 is a region in the photodetection element 4 that does not include the first region 8, the second region 10, or the third region 12, and performs photoelectric conversion of incident light. The photodetection region 6 is made of, for example, an i-type InSb compound semiconductor and has a carrier concentration of about 5×10^{15} to 1×10^{17}cm^{-3}. The first region 8 is

【図 1】

embedded in the photodetection element 4. The first region 8 is provided between the first surface 4a and the second surface 4b. The first region 8 extends from a part of the second surface 4b of the photodetection element 4 to the inside of the photodetection element 4 (with a thickness inside the photodetection element 4). The first region 8 is an n-type impurity semiconductor region (first impurity semiconductor region) and has a carrier concentration of about 1×10^{17} to 1×10^{19} cm^{-3}.” ([0009])

“The second region 10 is embedded in the photodetection element 4. The second region 10 is provided between the first surface 4a and the second surface 4b. The second region 10 extends from a part of the second surface 4b of the photodetection element 4 to the inside of the photodetection element 4 (with a thickness inside the photodetection element 4). The second region 10 is a p-type impurity semiconductor region (second impurity semiconductor region) and has a carrier concentration of about 1×10^{17} to 1×10^{19} cm^{-3}. The first region 8 and the second region 10 are provided apart from each other.”

([0010])

“Further, the second region 10 faces the separation groove 5. That is, a part or all of the side walls of the separation groove 5 belong to the second region 10. When the photodetection element 4 is adjacent to a plurality (for example, two) of separation grooves 5, the photodetection element 4 may have one second region 10 facing one of the plurality of adjacent separation grooves 5, or may have a plurality of second regions 10 facing all of the plurality of separation grooves 5. The first region 8 may be a p-type impurity semiconductor region (second impurity semiconductor region), and the second region 10 may be an n-type impurity semiconductor region (first impurity semiconductor region).” ([0011])

“The third region 12 is embedded in the photodetection element 4. The third region 12 extends from the first surface 4a of the photodetection element 4 to the inside of the photodetection element 4 (with a thickness inside the photodetection element 4). That is, the third region 12 is bonded to the compound semiconductor substrate 2. The third region 12 is formed over the entire region of the first surface 4a. The third region 12 is a p-type impurity semiconductor region and has a carrier concentration of about 1×10^{17} to 1×10^{19} cm^{-3}.

The third region 12 is provided apart from the first region 8 and the second region 10. Since it is difficult to provide a high-resistance InSb layer having good characteristics as a light-absorbing layer directly on the compound semiconductor substrate 2 made of semi-insulating GaAs, first, the third region 12 made of a low-resistance InSb layer containing impurities is directly provided on the compound semiconductor substrate 2 as a buffer layer, and then the photodetection region 6 is provided on the third region 12 as a light-absorbing layer made of a high-resistance InSb layer having good characteristics. The second region 10 and the third region 12 may be connected to each other (the second region 10 and the third region 12 may be formed as a continuous region).” ([0012]. Note by the body: since the “compound semiconductor substrate 12” in “ … having good characteristics … on the compound semiconductor substrate 12 made of semi-insulating GaAs” is an obvious error of the “compound semiconductor substrate 2”, recognition is made after the error is corrected.)

“The photodetection device 1 further includes a protective film 14 and a plurality of electrodes 16. The protective film 14 contains SiN, SiO and the like. The protective film 14 covers the second surface 4b of the photodetection element 4 and covers the inside of the separation groove 5 (side wall and bottom wall of the separation groove 5). Two contact holes (contact hole 14a and contact hole 14b) are provided in the protective film 14 for each of the plurality of photodetection elements 4. The contact hole 14a is provided

on the first region 8, and the contact hole 14b is provided on the second region 10. The plurality of electrodes 16 are for electrically connecting the plurality of photodetection elements 4 in series, and are separated from one another. The electrodes 16 are provided on the protective film 14 and the like. Each electrode 16 includes Ti/Au or Ti/Pt/Au, has a thickness equal to or greater than the depth of the separation groove 5 (or the thickness of the photodetection element 4 described above), and fills the interior of the separation groove 5 excluding the protective film 14 (the interior of the separation groove 5 is filled with the electrode 16). The electrode 16 is electrically connected to the first region 8 via the contact hole 14a. The electrode 16 is electrically connected to the second region 10 via the contact hole 14b. Thus, the electrode 16 extends from the first region 8 (contact hole 14a) of one of two photodetection elements 4 adjacent to each other with the separation groove 5 interposed therebetween to the second region 10 (contact hole 14b) of the other one of the two photodetection elements 4 via the separation groove 5. That is, the electrode 16 electrically connects the first region 8 of one of two adjacent photodetection elements 4 with the separation groove 5 interposed therebetween and the second region 10 of the other photodetection element 4. In this way, by the electrode 16 electrically connecting the first region 8 of one of two adjacent photodetection elements 4 with the separation groove 5 interposed therebetween and the second region 10 of the other photodetection element 4, a plurality of photodetection elements 4 are electrically connected in series. ([0013])

“As described above, the photodetection element 4 has an i-type photodetection region 6 and, for example, a p-type first region 8 and, for example, an n-type second region 10 between the first surface 4a and the second surface 4b. In this way, the photodetection device 1 has a planar type configuration in which the i-type photodetection region 6, the p-type first region 8, and the n-type second region 10 are provided between two surfaces of the photodetection element 4, and both the electrode 16 connected to the p-type first region 8 and the electrode 16 connected to the n-type second region 10 are provided on the second surface 4b, which is the main surface of the photodetection element 4. Further, the plurality of photodetection elements 4 are simply separated from one another by the separation groove 5. As described above, the photodetection device 1 has a relatively simple configuration. In addition, since the second region 10 (first or second impurity semiconductor region) faces the separation groove 5, the separation groove is formed in a low-resistance impurity semiconductor region, and thus the diffusion current from the photodetection region 6 is reduced. Further, since the electrode 16 has a thickness equal to or larger than the depth of the separation groove 5, sufficient strength can be secured for the separation groove 5. Therefore, the occurrence of breakage

and the like of the electrode 16 on the separation groove 5 or in the vicinity of the separation groove 5 is reduced. Furthermore, the electrode 16 fills the interior of the separation groove 5 excluding the protective film 14 (the interior of the separation groove 5 is filled with the electrode 16). Therefore, the occurrence of breakage and the like of the electrode 16 on the separation groove 5 or in the vicinity of the separation groove 5 is sufficiently reduced.” ([0014])

“Next, the method for manufacturing the photodetection device 1 will be described. First, the compound semiconductor substrate 2 is prepared, and an InSb layer having a carrier concentration of about 1×10^{17} to 1×10^{19} cm^{-3}, which forms the third region 12, is formed on the main surface 2a of the compound semiconductor substrate 2 to a thickness of about 0.5 to 1 μm by using the MBE (molecular beam epitaxy) method, the MOVPE (metalorganic vapor phase epitaxy) method, and the like, and then an InSb compound semiconductor layer (carrier concentration of about 5×10^{15} to 1×10^{17} cm^{-3}) is epitaxially grown on the InSb layer until the thickness of the InSb compound semiconductor layer is about 0.5 to 2 μm so as to form the light-absorbing layer 6 (first step). Following the first step, a plurality of the first and second impurity semiconductor regions are formed in the InSb compound semiconductor layer by using the diffusion method, the ion implantation method, and the like (second step). Specifically, the first and second impurity semiconductor regions are obtained by injecting an n-type dopant or a p-type dopant into the InSb compound semiconductor layer from the main surface of the InSb compound semiconductor layer (the surface of the InSb compound semiconductor layer on the opposite side of the surface bonded to the compound semiconductor substrate 2) by using the diffusion method, the ion implantation method, and the like. The first and second impurity semiconductor regions are formed so as to be alternately arranged in a predetermined direction (specifically, the direction in which the plurality of photodetection elements 4 are later connected in series).” ([0015]. Note by the body: since there is an obvious typing error in “obtained by injecting … into the InSb compound semiconductor layer”, recognition is made after the typing error is corrected.)

“Following the second step, the plurality of separation grooves 5 are provided on the InSb compound semiconductor layer at equal intervals along the above-mentioned predetermined direction by using wet etching, dry etching, and the like (third step). Thereby, the InSb compound semiconductor layer is divided into the plurality of photodetection elements 4. Accordingly, the plurality of photodetection elements 4 are separated from one another by the separation groove 5. Following the third step, the protective film 14 is formed on the photodetection element 4 and the like (fourth step). Specifically, the protective film 14 is formed so as to cover the second surface 4b of the

photodetection element 4 and the inside of the separation groove 5 (the side wall and the bottom wall of the separation groove 5).” ([0016])

“Following the fourth step, a plurality of contact holes 14a and contact holes 14b are formed on the protective film 14 by using wet etching with an acid such as citric acid + hydrogen peroxide or hydrochloric acid + hydrogen peroxide or dry etching such as ICP etching or ion milling (fifth step). Specifically, each contact hole 14a is formed on the first region 8 and each contact hole 14b is formed on the second region 10. A part of the surface of the first region 8 and a part of the surface of the second region 10 are exposed by forming the contact hole 14a and the contact hole 14b.” ([0017])

“Following the fifth step, the electrode 16 is formed on the protective film 14 and the like (sixth step). Specifically, a metal film of a metallic material such as Ti/Au or Ti/Pt/Au is deposited on the protective film 14 (including the interior of the separation groove 5), and in the contact hole 14a and the contact hole 14b by resistance heating, EB, and the like. The interior of the contact hole 14a, the interior of the contact hole 14b, and the interior of the separation groove 5 are filled with the metal material of the metal film. The metal film thus formed is electrically connected to the first region 8 and the second region 10 via the contact hole 14a and the contact hole 14b. The above-mentioned metal film is divided into the plurality of electrodes 16 by using the lift-off method and the like after such deposition by resistance heating, EB, and the like.” ([0018])

“In the above-mentioned example, a photodetection element having a wavelength band of about 5 μm using InSb as a light-absorbing region (photodetection region 6) is described, but the present invention is not limited thereto. For example, a photodetection element having a wavelength band of about 10 μm may be obtained by using $InAs_xSb_{1-x}$ as the light-absorbing region (photodetection region 6).” ([0019])

(B) An aspect relating to the “photodetection element having a wavelength band of about 5 μm using InSb as a light-absorbing region (photodetection region 6)” (hereinafter referred to as “InSb aspect”) and an aspect of the “photodetection element having a wavelength band of about 10 μm … by using $InAs_xSb_{1-x}$ as the light-absorbing region (photodetection region 6) (hereinafter referred to as “InAsSb aspect”) are described in [0019], and regarding the method for manufacturing the InAsSb aspect, what kind of configuration is described in Cited Document 1 will be examined.

a. First, according to [0019], it can be seen that the InAsSb aspect is obtained by replacing “InSb” of the “light-absorbing region (photodetection region 6)” in the InSb aspect with “$InAs_xSb_{1-x}$”.

Thus, it is recognized that in the InAsSb aspect, the “InSb compound

semiconductor layer" (the layer forms the "light-absorbing layer 6". See [0015]) in the "second step" ([0015]) and the third step ([0016]) is replaced with the "$InAs_xSb_{1-x}$ compound semiconductor layer".

b. Next, Cited Document 1 does not specify what is happening to the "InSb layer" forming the "third region 12" in the "first step" ([0015]) in the InAsSb aspect.

Meanwhile, according to the description that "since it is difficult to provide a high-resistance InSb layer having good characteristics as a light-absorbing layer directly on the compound semiconductor substrate 2 made of semi-insulating GaAs, first, the third region 12 made of a low-resistance InSb layer containing impurities is directly provided on the compound semiconductor substrate 2 as a buffer layer, and then the photodetection region 6 is provided on the third region 12 as a light-absorbing layer made of a high-resistance InSb layer having good characteristics" in [0012], it can be seen that the "InSb layer" forming the "third region 12" is used as the "buffer layer" in the InSb aspect. Further, since it can be said that the "high-resistance InSb layer having good characteristics" in the description is replaced with the "$InAs_xSb_{1-x}$ compound semiconductor layer" in the InAsSb aspect, the "$InAs_xSb_{1-x}$ compound semiconductor layer" is provided on the buffer layer that is the third region 12. Furthermore, it is common technical knowledge that the buffer layer and the layer provided on the buffer layer are made of layers having the same composition.

Thus, it is recognized that Cited Document 1 substantially describes that the "InSb layer" that is the "third region 12" is replaced with the "$InAs_xSb_{1-x}$ layer" in the InAsSb aspect.

B According to A above, it is recognized that Cited Document 1 describes the following invention (hereinafter, referred to as "Cited Invention 1") regarding the method for manufacturing the InAsSb aspect, that is, the aspect of the "photodetection element having a wavelength band of about 10 μm … by using $InAs_xSb_{1-x}$ as the light-absorbing region (photodetection region 6)". Paragraph numbers and the like used for recognizing Cited Invention 1 are shown in parentheses for reference.

"A method for manufacturing a photodetection device 1, the method comprising:

a first step of preparing a compound semiconductor substrate 2, forming an $InAs_xSb_{1-x}$ layer having a carrier concentration of about 1×10^{17} to 1×10^{19} cm^{-3}, which forms the third region 12, on the main surface 2a of the compound semiconductor substrate 2 to a thickness of about 0.5 to 1 μm by using the MBE (molecular beam epitaxy) method, the MOVPE (metalorganic vapor phase epitaxy) method, and the like, and

epitaxially growing an $InAs_xSb_{1-x}$ compound semiconductor layer (carrier concentration of about 5×10^{15} to 1×10^{17} cm^{-3}) on the $InAs_xSb_{1-x}$ layer until the thickness of the $InAs_xSb_{1-x}$ compound semiconductor layer is about 0.5 to 2 μm so as to form a light-absorbing layer 6 ([0015], A(B)b above);

a second step, which follows the first step, of forming a plurality of first and second impurity semiconductor regions in the $InAs_xSb_{1-x}$ compound semiconductor layer by using the diffusion method, the ion implantation method, and the like, the first and second impurity semiconductor regions being formed so as to be alternately arranged in a predetermined direction ([0015], A[B]a above]; and

a third step, which follows the second step, of providing a plurality of separation grooves 5 on the $InAs_xSb_{1-x}$ compound semiconductor layer at equal intervals along the above-mentioned predetermined direction by using dry etching, thereby dividing the $InAs_xSb_{1-x}$ compound semiconductor layer into a plurality of photodetection elements 4 ([0016], A[B]a above),

wherein the third region 12 is embedded in the photodetection element 4 ([0012]), and a photodetection element having a wavelength band of about 10 μm may be obtained by using $InAs_xSb_{1-x}$ as a light-absorbing region (photodetection region 6) ([0019])."

(2) Comparison

The Invention and Cited Invention 1 are compared.

A Regarding the specifying matter of the "method for fabricating an array of photodetectors" in the Invention

(A) The "photodetection element 4" in Cited Invention 1 corresponds to the "photodetector" in the Invention.

(B) Cited Invention 1 describes a "method for manufacturing a photodetection device 1" including a "third step of dividing the $InAs_xSb_{1-x}$ compound semiconductor layer into a plurality of photodetection elements 4", and therefore, it can be said that Cited Invention 1 describes a "method for fabricating an array of photodetectors" in the Invention.

(C) Accordingly, Cited Invention 1 includes the above-mentioned specifying matter of the Invention.

B Regarding a specifying matter of "providing an array of the photodetectors formed from InAsSb, which includes at least one trench (200) defined between adjacent photodetectors" in the Invention

(A) The "plurality of separation grooves 5" in Cited Invention 1 correspond to the "at least one trench" in the Invention.

(B) Cited Invention 1 describes “providing a plurality of separation grooves 5 on the $InAs_xSb_{1-x}$ compound semiconductor layer at equal intervals along the above-mentioned predetermined direction, thereby dividing the $InAs_xSb_{1-x}$ compound semiconductor layer into a plurality of photodetection elements 4”, and therefore, it can be said that the above-mentioned “plurality of separation grooves 5” are “defined between adjacent photodetectors” in the Invention 1.

(C) In Cited Invention 1, “$InAs_xSb_{1-x}$” is used “as a light-absorbing region (photodetection region 6)”, and the “third region 12” “embedded in the photodetection element 4” is made of the “$InAs_xSb_{1-x}$ layer”, and therefore, it can be said that the “photodetection element 4” in Cited Invention 1 (corresponding to the “photodetector” in the Invention) is “formed from InAsSb” in the Invention.

(D) Accordingly, Cited Invention 1 includes the above-mentioned specifying matter of the Invention.

C Regarding the specifying matter of “and dry etching the at least one trench with plasma containing BCl_3 and Ar” in the Invention

(A) Cited Invention 1 describes “ … which follows the second step, of providing a plurality of separation grooves 5 on the $InAs_xSb_{1-x}$ compound semiconductor layer at equal intervals along the above-mentioned predetermined direction by using dry etching”, and thus includes the specifying matter of “dry etching at least one trench” in the Invention.

(B) However, Cited Invention 1 does not include the specifying matter that “dry etching” is performed “with plasma containing BCl_3 and Ar.”

D Regarding the specifying matter of the “method comprising” in the Invention

According to A above, Cited Invention 1 includes the above-mentioned specifying matter of the Invention.

(3) Recognition of a corresponding feature and a different feature

According to (2) above, the Invention and Cited Invention 1 are identical in the matter of “a method for fabricating an array of photodetectors, the method comprising: providing an array of the photodetectors formed from InAsSb, which includes at least one trench (200) defined between adjacent photodetectors; and dry etching at least one trench,” and are different in the following matter.

[Different Feature]

Dry etching at least one trench is performed “with plasma containing BCl_3 and Ar” in the Invention, which, however, is not specified in Cited Invention 1.

(4) Judgment for the different feature

A It is a well-known technique to perform dry etching on semiconductors with plasma containing BCl_3 and Ar (for example, see [0004] in National Publication of International Patent Application No. 2013-510442, [0015] and FIG. 2 in National Publication of International Patent Application No. 2008-510303, [0019] to [0023] in Japanese Unexamined Patent Application Publication No. H9-171990, and [0015] and [0016] in Japanese Unexamined Patent Application Publication No. H10-27783. All of them are presented in the examiner’s decision.).

Thus, in Cited Invention 1, a person skilled in the art could have appropriately arrived at obtaining the configuration according to the different feature by performing dry etching on the at least one trench with plasma containing BCl_3 and Ar.

B Regarding in (1)A(B)b above, in case it cannot be said that Cited Invention 1 substantially describes that the “InSb layer” that is the “third region 12” is replaced with the “$InAs_xSb_{1-x}$ layer” in the InAsSb aspect, the Invention and Cited Invention 1 differ further in that the “array of the detectors” is “formed from InAsSb” in the Invention, which, however, is unclear in Cited Invention 1.

However, according to the explanation in (1)A(B)b above, a person skilled in the art could have appropriately arrived at obtaining the configuration according to the different feature by adopting the “$InAs_xSb_{1-x}$ layer” or the “InAsSb layer” as the “third region 12” in Cited Invention 1.

C The effect of obtaining the configuration according to the different feature cannot be said to be remarkable.

D Therefore, the Invention could have been easily made by a person skilled in the art based on the cited inventions and the well-known technique, and thus cannot be granted a patent under the provision of the Patent Act Article 29(2).

No. 4 Closing

As described above, since Amendment 1 does not satisfy the requirement as provided in the Patent Act Article 17-2(3), and the Invention cannot be granted a patent under the provision of the Patent Act Article 29(2), the present application should be

rejected without considering the inventions according to other claims.

Therefore, the appeal decision shall be made as described in the conclusion.

July 30, 2021

Chief administrative judge: INOUE, Hiroyuki
Administrative judge: YAMAMURA, Hiroshi
Administrative judge: MATSUKAWA, Naoki