#### Appeal decision

Appeal No. 2017-15802

South Korea Appellant	Samsung SDI Co., Ltd.
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The case of appeal against the examiner's decision of refusal of Japanese Patent Application No. 2012-212035, titled "ELECTRODE CATALYST FOR FUEL CELL, METHOD OF PREPARING THE SAME, AND MEMBRANE ELECTRODE ASSEMBLY INCLUDING THE ELECTRODE CATALYST AND FUEL CELL" (the application published on April 22, 2013, Japanese Unexamined Patent Application Publication No. 2013-73940) has resulted in the following appeal decision.

#### Conclusion

The appeal of the case was groundless.

#### Grounds

No. 1 History of the procedures

The present application was filed on September 26, 2012 (claiming priority under Paris Convention for the Protection of Industrial Property with a priority date of September 27, 2011, South Korea (KR)), a notice of reasons for refusal dated May 31, 2016 was issued, a written opinion and a written amendment were submitted on September 2, 2016, a notice of reasons for refusal dated October 28, 2016 was issued, a written amendment were submitted on February 6, 2017, and a decision of refusal was made on June 15, 2017.

In response, the appeal against the examiner's decision of refusal was filed on October 25, 2017 together with a written amendment, a notice of reasons for refusal dated May 7, 2018 was issued by the body, and a written opinion and a written amendment were submitted on August 14, 2018.

#### No. 2 Regarding the invention

The inventions according to Claims 1 to 15 of the present application (hereinafter referred to as "Present Invention 1" to "Present Invention 15", respectively) are specified as below by the matters described in Claims 1 to 15 of the scope of the claims that have been amended by the amendment on August 14, 2018:

### "[Claim 1]

An electrode catalyst for a fuel cell, the electrode catalyst comprising a crystalline catalyst particle comprising:

a Group 13 element; and a precious metal having oxygen reduction activity;

wherein said Group 13 element is present as an interstitial-type atom between precious metal atoms forming a unit lattice of said precious metal,

wherein the precious metal comprises palladium (Pd),

wherein the Group 13 element comprises indium (In).

[Claim 2]

The electrode catalyst of Claim 1, further comprising a transition metal comprising at least one of cobalt (Co), copper (Cu), iron (Fe), nickel (Ni), manganese (Mn), cerium (Ce), and titanium (Ti).

[Claim 3]

The electrode catalyst of Claim 2, wherein the transition metal comprises at least one of cobalt (Co), copper (Cu), and manganese (Mn).

[Claim 4]

The electrode catalyst of Claim 1, satisfying the following mathematical formula 1:

[Expression 1]

 $A_2 > A_1$ 

In said mathematical formula 1,

A2 is a lattice constant of the crystalline catalyst particle and

A1 is a lattice constant of a first catalyst particle that has the same structure as the crystalline catalyst particle except that the Group 13 element is not included therein. [Claim 5]

The electrode catalyst of Claim 1, further comprising a carbonaceous support. [Claim 6]

The electrode catalyst of Claim 1, wherein the amount of the Group 13 element is in a range of 0.001 to 20 parts by weight on the basis of 100 parts by weight of the electrode catalyst for a fuel cell.

[Claim 7]

A method of preparing an electrode catalyst for a fuel cell, the method comprising:

preparing a mixture comprising a precursor of a Group 13 element and a precursor of a precious metal having oxygen reduction activity;

reducing the precursors in the mixture to form an electrode catalyst that is used in a fuel cell and comprises a crystalline catalyst particle incorporating a Group 13 element and a precious metal having oxygen reduction activity, wherein the Group 13 element is present as an interstitial-type atom between precious metal atoms forming a unit lattice of said precious metal,

wherein the precious metal comprises palladium (Pd),

wherein the Group 13 element comprises indium (In).

[Claim 8]

The method of Claim 7, wherein the precursor of the Group 13 element comprises at least one compound of chlorides, nitrides, cyanides, sulfides, bromides, nitrates, acetates, sulfates, oxides, hydroxides, salts of oxygen acids, and alkoxides, each of which is a salt of the Group 13 element. [Claim 9]

The method of Claim 7, wherein the mixture further comprises a carbonaceous support.

## [Claim 10]

The method of Claim 7, wherein the mixture further comprises at least one of a glycol-based solvent and an alcohol-based solvent.

[Claim 11]

A membrane electrode assembly for a fuel cell, the membrane electrode assembly comprising:

a cathode;

an anode disposed facing the cathode; and

an electrolyte membrane interposed between the cathode and the anode,

wherein at least one of the cathode and the anode comprises the electrode catalyst of any of Claims 1 to 6.

[Claim 12]

The membrane electrode assembly of Claim 11, wherein the cathode comprises the electrode catalyst.

[Claim 13]

A fuel cell comprising the membrane electrode assembly of Claim 12. [Claim 14]

An electrode catalyst for a fuel cell comprising palladium (Pd) and iridium (Ir) and indium (In), the electrode catalyst comprising a crystalline catalyst particle in which In is present as an interstitial-type atom between precious metal atoms forming a unit lattice with a composition of Pd5Ir.

[Claim 15]

An electrode catalyst for a fuel cell, the electrode catalyst comprising a crystalline catalyst particle comprising: and a precious metal and Indium (In) having oxygen reduction activity; wherein said Indium (In) is present as an interstitial-type atom between precious metal atoms forming a unit lattice of said precious metal, and the catalyst satisfying the following mathematical formula 2:

[Expression 2]

 $A_2 > A_1$ 

In said mathematical formula 2,

A2 is a lattice constant of the crystalline catalyst particle and

A1 is a lattice constant of a first catalyst particle that has the same structure as the crystalline catalyst particle except that said Indium (In) is not included therein."

No. 3 Summary of the notice for reasons for refusal by the body

The summary of reasons for refusal notified by the body on May 7, 2018 is set forth below:

Claim 1 (Note for the body: Claim 1 of the scope of the claims that has been amended by the written amendment on October 25, 2017) specifies that

"An electrode catalyst for a fuel cell, the electrode catalyst comprising a crystalline catalyst particle comprising: a Group 13 element; and a precious metal having oxygen reduction activity; wherein the Group 13 element is present in a unit lattice of said precious metal,

wherein the precious metal comprises palladium (Pd), wherein the Group 13 element comprises indium (In)."

As a result, it can be said as including "crystalline catalyst particle" specified by the matters of "comprising Pd and In, wherein said In is present between Pd atoms forming a unit lattice of said Pd."

It cannot be said that a person skilled in the art could produce a "crystalline catalyst particle" specified by the matters of "comprising Pd and In, wherein said In is present between Pd atoms forming a unit lattice of said Pd" without undue trials and errors on the basis of the Detailed Description of the Invention of the specification and the common technical knowledge as of the filing.

Therefore, the Detailed Description of the Invention of this application fails to disclose definitely and sufficiently to the extent that allows a person skilled in the art to implement the invention according to Claim 1. Further, similarly, the Detailed Description of the Invention of this application does not describe definitely and sufficiently to the extent that allows a person skilled in the art to implement the inventions according to Claims 2 to 15, and thus the Detailed Description of the present application fails to conform to the requirement of Article 36(4)(i) of the Patent Act.

No. 4 Judgment by the body

In this column, first, in relation to the description of the specification and drawings (hereinafter these are collectively referred to as "the specification of the present application") attached to the application of the present application in item 1, and subsequently in item 2, consideration is given as to whether or not the Detailed Description of the Invention of the specification of the present application conforms to the enablement requirement as provided in Article 36(4)(i) of the Patent Act, and finally in item 3, consideration is given to the Appellant's allegation.

Hereinafter, a detailed explanation is given in the above-mentioned order.

1 Description of the specification

The specification of the present application has the following descriptions (underlined by the body, omissions of the description are shown by "...".).

"[Brief description of the drawing(s)]

[0024]

[FIG. 1A] A schematic diagram of a unit lattice of a first crystal catalyst particle with the same structure as a crystalline catalyst particle depicted in Figure 1B, except that the first catalyst particle does not include a Group 13 element.

[FIG. 1B] A schematic diagram of a unit lattice of a crystalline catalyst particle of an electrode catalyst according to an embodiment of the present invention."

"[0025]

An electrode catalyst for a fuel cell (hereinafter also referred to as "electrode catalyst") according to an embodiment of the present invention includes a crystalline catalyst particle including a Group 13 element and a precious metal having oxygen reduction activity. In this regard, the Group 13 element is present inside a unit lattice of the crystalline catalyst particle."

### "[0028]

The Group 13 element may improve the oxygen reduction activity of the crystalline catalyst particle by changing the crystal structure or electronic structure of the precious metal. For example, the Group 13 element may include at least one of boron (B), aluminum (Al), gallium (Ga), indium (In), and thallium (Tl). For example, the Group 13 element may include at least one of boron (B) and indium (In), but is not limited thereto."

### "[0036]

Mathematical formulae 5 to 7 may be further easily understood with reference to FIGS. 1A and 1B. FIG. 1B is a schematic diagram of a unit lattice 20 of the crystalline catalyst particle of the electrode catalyst (hereinafter referred to as "the unit lattice 20") according to an embodiment of the present invention, and FIG. 1A is a schematic diagram of a unit lattice 10 of the first catalyst particle (hereinafter referred to as "the unit lattice 10") having the same structure as the unit lattice 20 of a crystalline catalyst particle, except that the Group 13 element is not included. [0037]

The unit lattice 20 and the unit lattice 10 are configured by a regular sequence of the aforesaid atom of precious metal 22 and the atom of transition metal 12. The unit lattice 20, unlike the unit lattice 10, further includes an atom 24 of the Group 13 element in the unit lattice 20. The atom 24 of the Group 13 element may be present between the atoms 22 of the precious metal or transition metal that form the unit lattice 20.

[0038]

Due to the inclusion of the atom 24 of the Group 13 into the unit lattice 20, the distance(s) between crystal surfaces that are parallel to each other (D2(X), D2(Y), and D2(Z)) in the unit lattice 20 may be longer than a distance (s) between crystal surfaces that are parallel to each other (D1(X), D1(Y), and D1(Z)) in the unit lattice 10."

"[0047]

As confirmed by Mathematical formulae 5 to 8, <u>the insertion of an atom of the</u> <u>Group 13 element into a unit lattice of the crystalline catalyst particle leads to an</u> <u>increase in the distance between crystal surfaces of the crystalline catalyst particle and</u> <u>the lattice constant, so that the crystal structure and/or electron structure of the</u> <u>crystalline catalyst particle is changed.</u> In detail, the atom of the Group 13 element changes the density of outer electrons of the precious metal in the unit lattice of the crystalline catalyst particle to change the reactivity of the catalyst particle with oxygen. Accordingly, a fuel cell employing the electrode catalyst including the crystalline catalyst particle described above may have excellent electrical performance."

"[0080]

(Example) (Example 1: Preparation of Pd-B/C catalyst) 50 g of 0.1 wt% Pd(NO3)2 aqueous solution and 50 g of 0.1 wt% H3BO3 aqueous solution were mixed to prepare a precursor mixture.

## [0081]

Separately, 0.5 g of KB (ketjen-black (registered trademark), 800 m<sup>2</sup>/g) as a carbonaceous support was dispersed in 100 g of H2O to prepare a carbonaceous support mixture.

## [0082]

The precursor mixture and the carbonaceous support mixture were mixed and then 10.5 g of 1 M NaOH aqueous solution was added thereto, followed by stirring for 30 minutes to prepare a mixture having a pH of 10 to 11. Then, an NaBH4 aqueous solution was added thereto to form a Pd-B catalyst particle on the carbonaceous support by reduction. The resultant product was filtered, washed, and dried to prepare a Pd-B/C catalyst in which, theoretically (by calculation), a 50 wt% Pd-B catalyst particle was supported by the carbonaceous support. That is, B was now present in the Pd unit lattice at an atomic ratio of Pd:B at 20:1.

[0083]

(Example 2: Preparation of Pd2Ir-B/C catalyst)

A Pd2Ir-B/C catalyst, in which, theoretically, a 50 wt% Pd2Ir-B catalyst particle was supported by a carbonaceous support, was prepared in the same manner as in Example 1, except that 50 g of a 0.1 wt% IrCl3 aqueous solution was additionally used in preparing the precursor mixture. B was now present in the unit lattice of Pd and Ir at an atomic ratio of Pd:Ir:B at 2:1:3/20.

[0084]

(Example 3: Preparation of Pd5Ir-B/C catalyst)

A Pd5Ir-B/C catalyst, in which, theoretically, a 50 wt% Pd5Ir-B catalyst particle was supported by a carbonaceous support, was prepared in the same manner as in Example 1, except that 20 g of a 0.1 wt% IrCl3 aqueous solution was additionally used in preparing the precursor mixture. B was now present in the unit lattice of Pd and Ir at an atomic ratio of Pd:Ir:B of 5:1:6/20.

... [0089]

(Example 8: Preparation of Pd2Ir-In/C catalyst)

A Pd2Ir-In/C catalyst, in which, theoretically, a 50 wt% Pd2Ir-In catalyst particle was supported by a carbonaceous support, was prepared in the same manner as in Example 2, except that 50 g of a 0.1 wt% In(OH)3 aqueous solution was used instead of the H3BO3 aqueous solution in preparing the precursor mixture. In was present in the unit lattice of Pd and Ir at an atomic ratio of Pd:Ir:In of 2:1:0.2. [0090]

(Example 9: Preparation of Pd5Ir-In/C catalyst)

A Pd5Ir-In/C catalyst, in which, theoretically, a 50 wt% Pd5Ir-In catalyst particle was supported by a carbonaceous support, was prepared in the same manner as in Example 3, except that 0.5 g of a 0.1 wt% In(OH)3 aqueous solution was used instead of the H3BO3 aqueous solution in preparing the precursor mixture. In was now present in the unit lattice of Pd and Ir at an atomic ratio of Pd:Ir:In of 5:1:0.5."

"[FIG. 1A]



"[FIG. 1B]



2 Whether or not the Detailed Description of the Invention of the specification of the present application conforms to the requirement of Article 36(4)(i) of the Patent Act

(1) Present Invention 1 is a product invention directed to "an electrode catalyst for fuel cell". The working of an invention in the case of a product invention includes an action

of producing, using, etc. thereof (Article 2(3)(i) of the Patent Act). Therefore, with respect to a product invention, the conformance of the Detailed Description of the Invention of the specification to the enablement requirement as provided in Article 36(4)(i) of the Patent Act should be determined as to whether or not it is described to the extent that allows a person skilled in the art to produce and use the product on the basis of the description of the Detailed Description of the Invention of the specification and the common technical knowledge as of the filing without undue trials and errors.

(2) Matters specified in Present Invention 1

A The present Invention 1 comprises the matter that "said Group 13 element is present as an interstitial-type atom between precious metal atoms forming a unit lattice of said precious metal". Consideration is given hereinafter to the meaning of the matter.

(A) According to the common technical knowledge, crystalline substances form a steric lattice with constituent molecules and atoms positioned regularly and periodically in a three-dimensional space. The minimum unit of the lattice is called a "unit lattice."

(B) Consequently, the matter that "said Group 13 element is present as an interstitial-type atom between precious metal atoms forming a unit lattice of said precious metal" of Present Invention 1

- means that "the presence" of said "Group 13 element" is carried out by the "insertion" of said "Group 13 element" between precious metal atoms with relative positions of the precious metal atoms forming a minimum unit lattice retained (the positions of the precious metal atoms may be varied to some extent by a distortion associated with "insertion", so-called insertion type solid solution); but

- does not mean "the presence" of said "Group 13 element" is carried out by replacing a precious metal atom forming a unit lattice as a minimum unit with said "Group 13 element" (so-called substitution-type solid solution).

(C) It is recognized that the construction of the above (B) is consistent with the description of the specification of the present application.

Specifically, according to paragraph [0036], Figure 1B schematically depicts a "unit lattice 20 of crystalline catalyst particle of one embodiment," and Figure 1A schematically depicts a "unit lattice 10 of the first catalyst particle having the same structure as the unit lattice 20 of a crystalline catalyst particle, except that the Group 13 element is not included." It can be said that Figure 1B schematically depicts the presence of a white circle (24: corresponding to the atom of Group 13 element) showing the atom of said Group 13 element by "inserting" a white circle (24) between black circles (12: corresponding to a precious metal atom) while maintaining the position of the black circle (12) of Figure 1A. Thus it is consistent with the construction of the above (B).

(D) Furthermore, the construction of the above (B) is consistent with the Appellant's allegation in Appeal Brief or the written statement on March 19, 2018.

B Further, a "crystalline catalyst particle" included in an "electrode catalyst for fuel cell" of Present Invention 1 is specified by the matter that "said precious metal is

palladium (Pd) and said Group 13 element is indium (In)" in addition to the matter that "said Group 13 element is present as an interstitial-type atom between precious metal atoms forming a unit lattice of said precious metal", which was examined in the above A.

The former matter specifies "precious metal" and "Group 13 element" of the former matter as "palladium (Pd)" and "indium (In)", respectively.

Therefore, it can be said that a "catalyst particle for fuel cell" of Present Invention 1 includes "crystalline catalyst particle" to be specified by the matter of "comprising Pd and In, wherein said In is present as an interstitial-type atom between Pd atoms forming a unit lattice of said Pd."

C In the following (3), consideration is given as to whether or not the Detailed Description of the Invention of the specification of the present application conforms to the enablement requirement for Present Invention 1 on the basis of the construction given in the above A(B) and B.

(3) Consideration as to whether or not the Detailed Description of the Invention of the specification of the present application conforms to the enablement requirement for Present Invention 1

A As shown in the above (2), a "crystalline catalyst particle" included in "electrode catalyst for fuel cell" of Present Invention 1 is specified by the matters of "comprising Pd and In, wherein said In is present as an interstitial-type atom between Pd atoms forming a unit lattice of said Pd".

In view of the above (1), in order to find that the Detailed Description of the Invention of the specification conform to the enablement requirement as provided in Article 36(4)(i) of the Patent Act with respect to Present Invention 1, it is required that a person skilled in the art could produce a "crystalline catalyst particle" "comprising Pd and In, wherein said In is present as an interstitial-type atom between Pd atoms forming a unit lattice of said Pd" as specified in Present Invention 1 without undue trials and errors on the basis of the Detailed Description of the Invention of the specification of the present application and the common technical knowledge as of the filing.

B According to the common technical knowledge as of the filing of the present application (see E-1 and E-2 of the following E), atoms capable of "being present as an interstitial-type atom between Pd atoms forming a unit lattice of said Pd" are limited to the atoms H, B, C, N, and O, which are of a small size.

The atom "In" is bigger than the atoms "H" and "B" etc., and also bigger than the atom "Pd" (see E-4 of the following E).

Consequently, according to the common technical knowledge as of the filing of the present application, it cannot be recognized that the matter that "said In is present as an interstitial-type atom between Pd atoms forming a unit lattice of said Pd" can be realized since it discords from the common technical knowledge.

C Further, referring to the whole disclosure of the specification of the present application, it is not proved that "said In is present as an interstitial-type atom between Pd atoms forming a unit lattice of said Pd," which discords from the common technical knowledge.

In addition, the specification of the present application has the following

descriptions (A) to (D):

(A) "The unit lattice 20, unlike the unit lattice 10, further includes an atom 24 of the Group 13 element in the unit lattice 20. The atom 24 of the Group 13 element may be present between the atoms 22 of the precious metal or transition metal that form the unit lattice 20." (Paragraph [0037])

(B) "Due to the inclusion of the atom 24 of the Group 13 into the unit lattice 20, the distance(s) between crystal surfaces that are parallel to each other (D2(X), D2(Y), and D2(Z)) in the unit lattice 20 may be longer than a distance(s) between crystal surfaces that are parallel to each other (D1(X), D1(Y), and D1(Z)) in the unit lattice 10." (Paragraph [0038])

(C) "The insertion of an atom of the Group 13 element into a unit lattice of the crystalline catalyst particle leads to an increase in the distance between crystal surfaces of the crystalline catalyst particle and the lattice constant, so that the crystal structure and/or electron structure of the crystalline catalyst particle is changed." (Paragraph [0047])

(D) Figure 1B (see the aforesaid item 1)

However, the descriptions of the above (A) to (C) only describe the matter that the atom 24 of the Group 13 element may be present between the atoms 22 of precious metal (or transition metal) forming a unit lattice 20. In view of the consideration of the above B, it can be said to be a reasonable explanation for a case that the Group 13 element is "B" of a small atom size, but it cannot be said to be a reasonable explanation for a case of "In" of a large atom size, nor can it be a ground for the realization of the matter that "said In is present as an interstitial-type atom between Pd atoms forming a unit lattice of said Pd."

Further, FIG. 1B is "a schematic diagram of a unit lattice of a crystalline catalyst particle" (paragraph [0024]), which only schematically illustrates the descriptions of the above (A) to (C). This cannot be a ground for the realization of the matter that "said In is present as an interstitial-type atom between Pd atoms forming a unit lattice of said Pd."

Comprehensively taking into account the other descriptions of the specification of the present application, there is no ground sufficient to find that the matter that "said In is present as an interstitial-type atom between Pd atoms forming a unit lattice of said Pd", which discords from the common technical knowledge, can be realized.

Furthermore, comprehensively taking into account the other descriptions of the written opinion dated August 14, 2018, Appeal Brief and the written statement on March 19, 2018, there is no ground sufficient to find that the matter that "said In is present as an interstitial-type atom between Pd atoms forming a unit lattice of said Pd" can be realized, as shown in the following item 3.

D Therefore, it cannot be said that a person skilled in the art could produce a "crystalline catalyst particle" specified by the matters of "comprising Pd and In, wherein said In is present between Pd atoms forming a unit lattice of said Pd" without undue trials and errors on the basis of the Detailed Description of the Invention of the specification of the present application and the common technical knowledge as of the filing.

Therefore, it cannot be said that the Detailed Description of the Invention of the present specification conforms to the enablement requirement for Present Invention 1.

E The matters shown in the following E-1 to E-4 are present as common technical knowledge as of the filing of the present application.

E-1: When the other atom M2 is subjected to solid solution into Metal M1, there are two cases; the case where the other atom M2 is inserted between the atoms of Metal M1 forming a crystal lattice (insertion type), and the case where the other atom M2 is replaced with the atom of Metal M1 forming a crystal lattice (substitution type).

E-2: First of all, a large gap is not present between atoms forming a crystal lattice. Thus the other atom M2 is inserted between the atoms of Metal M1 forming a crystal lattice (insertion type) only in a case that the size of the other atom M2 is small, which is limited to a case where the other atom M2 is H, B, C, N, or O.

E-3: Regarding a peak shift of X-ray diffraction pattern, the shift to a lower angle means a larger lattice constant, whereas the shift to a higher angle means a smaller lattice constant. Such peak shift can take place also in a case where the other atom M2 is replaced with the atom of Metal M1 forming a crystal lattice (substitution type).

E-4: A size of In atom is larger than a size of B atom, and also larger than the size of Pd atom.

(A) Grounds for E-1 and E-2

a "Masahiro Kitada, Elementary Metal Physics, Japan, January 21, 1978, pages 29 to 33" cited in the original decision as Cited Document 7 has the following description on page 29 to page 31:

"

b. 格子間原子 "b. Interstitial atom

完全結晶の中に、この結晶を構成している原子以外の異種原子(foreign atom [<sup>f5rin detem</sup>];よそもの原子)を入れることを考えてみよう。完全結晶では格子点のすべてが満たされているので、格子点に異種原子を入れることはできない。そこで、図3.2で示すように、原子と原子のすき間にむりやり押し込まねばならない。このように、格子点以外の原子のすき間(格子間隙)に入った原子を格子間原子(こうしかんげんし、interstitial atom [<sup>interstifel detem</sup>])あるいは格子間に侵入したという意味で侵入型原子(しんにゅうがたげんし)という。

Suppose that a foreign atom (<sup>f5rin detam</sup>) other than an atom constituting this crystal be included in a perfect crystal. In a perfect crystal, all the grid points are occupied. Thus it is impossible to include a foreign atom in a grid point. Therefore, as shown in Figure 3.2, the foreign atom is forced to be inserted into a gap between atoms. As described above, an atom inserted into a gap between atoms other than grid points is referred to as an interstitial atom (<sup>inta:stifal detam</sup>) or an interstitial-type atom in

the sense that it is inserted interstitially.

完全結晶では、すべての格子点を同種の原子が占めており、格子のすき間な どに原子が入り込むと結晶の完全性が崩れる。したがって、格子間原子の存在 するような結晶も不完全結晶であり、格子間原子も点欠陥の一つである。図3. 2から明らかなように、原子と原子のすき間非常に小さいから、格子間原子と なれるような原子は金属原子より非常に小さい酸素、窒素、炭素、ホウ素、水 素などの非金属元素に限られる。 In a perfect crystal, all the grid points are occupied by a similar kind of atoms, and thus the integrity of crystal collapses if an atom is inserted into a gap of lattice etc. Therefore, a crystal including an interstitial atom is also an imperfect crystal, and an interstitial atom is one of point defects. As is evident from Figure 3.2, a gap between atoms is so small that an atom that may become an interstitial atom is limited to non-metal elements such as oxygen, nitrogen, carbon, boron, and hydrogen, which are very small compared to metal atoms.

しかし、結晶に中性子などを当ててむりやり原子をはじき飛ばす場合などに は、同種原子でも格子間位置へ侵入する。 In a case of forcedly flicking off an atom by irradiating crystals with a neutron, a similar kind of atom is also inserted into an interstitial site.

c. 置換型原子 c. Substitutional atom

原子と原子のすき間に原子を入り込ませることを考えたが、完全結晶に異種 原子が入り込む方法はこれだけであろうか。 In the foregoing, consideration is given to the insertion of an atom into a gap between atoms. Is there any other method to insert a foreign atom into a perfect crystal?

完全結晶とは、図3.1(a)のように同種の原子がすべての格子点を占めている状態であるから、格子点の一つを異種原子の位置に置き換えれば不完全結晶となる。 Perfect crystal is in a state where all the grid points are occupied by a similar kind of atom, as shown in Figure 3.1(a). Thus if one of the grid points is replaced with a position of a different kind of atoms, it becomes an imperfect crystal.

完全結晶には格子間原子以外の大きな異種原子が入り込む余地はないが、空 孔を含む不完全結晶であれば図3.3のように異種原子を入れることができる。

Perfect crystal has no room for a large foreign atom other than interstitial atom to be inserted, whereas an imperfect atom including a void may insert a foreign atom as shown in Figure 3.3.

格子点に異種原子を入れるためには、原子を一つ取り除いて空孔をつくり、 元の原子に置き換える形で入りこませるので、置換型原子(ちかんがたげんし、 substitutional atom [[sʌbstitjú: ʃənəl @təm] )という。 To insert a foreign atom into a grid point, one atom is removed to make a void and the void is replaced with the foreign atom. Thus it is referred to as a substitutional atom ([sʌbstitjú: ʃənəl @təm).

図3.2 結晶格子間(原子の間のすき間)に入り込んだ不純物原子、格子間

原子あるいは侵入型原子と呼ぶ Figure 3.2 Referred to as impurity atom, interstitial atom or interstitial-type atom inserted into a gap between a crystal lattice (a gap between atoms)

#### b. 格子間原子

完全結晶の中に、この結晶を構成している原子以外の異種原子(foreign atom [fórin étəm];よそもの原子)を入れることを考えてみよう、完全結晶では格子点のすべてが満 たされているので、格子点に異種原子を入れることはできない、そこで、図3.2で示すよ うに、原子と原子のすき間にむりやり押し込まねばならない、このように、格子点以外の 原子のすき間(格子間隙)に入った原子を格子間原子(こうしかんげんし、interstitial atom[intə:stifəl étəm])あるいは格子間に侵入したという意味で侵入型原子(しんにゅう がたげんし)という.

完全結晶では、すべての格子点を同種の原子が占めており、格子のすき間などに原子が 入り込むと結晶の完全性が崩れる、したがって、格子間原子の存在するような結晶も不完 全結晶であり、格子間原子も点欠陥の一つである。図3.2から明らかなように、原子と原 子のすき間は非常に小さいから、格子間原子となれるような原子は金属原子より非常に小 さい酸素, 窒素, 炭素, ホウ素, 水素などの非金属元素に限られる.

しかし,結晶に中性子などを当ててむりやり原子をはじき飛ばす場合などには,同種原 子でも格子間位置へ侵入する.

#### c. 置換型原子

原子と原子のすき間に原子を入り込ませることを考えたが、完全結晶に異種原子が入り 込む方法はこれだけであろうか、完全結晶とは、図 3.1(a)のように同種の原子がすべての

図 3.2 結晶格子間(原子の間のすき間)に入り 込んだ不純物原子,格子間原子あるいは侵入型原 子と呼ぶ

" (page 29)

(a) 空孔の形成 "(a) Formation of void

(b) 空孔のあとへ置き換って入った不純物原子 (b) Impurity atom inserted by replacing void

0000

図3.3 置換型不純物原子 Figure 3.3 Substitutional impurity atom

d. 点欠陥による格子のひずみ d. Lattice distortion due to point defect

列を乱さず整然と並んでいた原子は、空孔、格子間原子、置換型原子の存在 によって列を乱される。 An atom arranged in neat rows without falling out of line falls out of line due to the presence of a void, interstitial atom, or substitutional atom.

原子は斥力と引力の釣合った位置で静止した状態となっているから、空孔が

あれば空孔のある格子点からの斥力がなくなるので、周囲の原子は空孔のある 向きへずれる。図3.4(a)は空孔周囲の原子の位置のずれを示したもので、 完全結晶の格子が変形しており、これを格子のひずみという。格子間原子が存 在する場合、格子は格子間原子とは逆向きにひずむ(b)。 An atom stands still at a position where a repulsive force balances an attracting force. Thus a repulsive force from a grid point where a void is present is lost. As a result, surrounding atoms move toward the void. Figure 3.4(a) shows a positional deviation of atoms surrounding a void, in which a lattice of perfect crystal is deformed. This is referred to as a lattice distortion. In the presence of an interstitial atom, a lattice is distorted opposite to the interstitial atom (b).

(a) 空孔周囲の格子のひずみ (a) Lattice distortion around void

(b) 侵入型原子による格子のひずみ (b) Lattice distortion due to an interstitial-type atom

図3.4 欠陥が入ったことによる結晶格子のひずみ Figure 3.4 Distortion of crystal lattice due to the insertion of defects



格子点を占めている状態であるから、格子点の一つを異種原子の位置に置き換えれば不完 全結晶となる、完全結晶には格子間原子以外の大きな異種原子が入り込む余地はないが、 空孔を含む不完全結晶であれば図 3.3 のように異種原子を入れることができる。格子点に 異種原子を入れるためには、原子を一つ取り除いて空孔をつくり、元の原子に置き換える 形で入りこませるので、置換型原子(ちかんがたげんし、substitutional atom[sábstitjú: fənəl ætəm])という。

d. 点欠陥による格子のひずみ

列を乱さず整然と並んでいた原子は、空孔、格子間原子、置換型原子の存在によって列 を乱される。

原子は斥力と引力の釣合った位置で静止した状態となっているから、空孔があれば空孔 のある格子点からの斥力がなくなるので、周囲の原子は空孔のある向きへずれる.図3.4(a) は空孔周囲の原子の位置のずれを示したもので、完全結晶の格子が変形しており、これを格 子のひずみという.格子間原子が存在する場合、格子は格子間原子とは逆向きにひずむ(b).



" (page 30)

"

第3章 金属結晶中の点欠陥 31 crystal 31



(a)母結晶より大きい不純物

(a) Impurity larger than mother crystal

(b)母結晶より小さい不純物

(b) Impurity smaller than mother crystal

30

(c) 母結晶と同じ大きさの不純物 mother crystal

図3.5 置換型原子の大きさと結晶格子のひずみ方 Figure 3.5 Size of substitutional atom and manner of distortion of crystal lattice

置換原子の場合には、置換原子の大きさによって格子のひずみの程度は異な り、母結晶(ぼけっしょう)の原子より大きい原子であれば図3.5(a)の ように周囲の格子を押し拡げ、小さければ空孔と同様に周囲から押される (b)。母結晶と同じ大きさの原子であれば、格子のひずみは生じないが (c)、原子間結合力や斥力が母結晶原子といちじるしく異なる場合には、周 囲の母結晶をひずませる。 In a case of substitutional atom, a degree of distortion of lattice differs depending on a size of the substitutional atom. If the atom is larger than that of the mother crystal, it expands a surrounding lattice as shown in Figure 3.5(a), and if smaller, it is pushed from the surrounding in a similar manner to void (b). If the atom has the same size as that of the mother crystal, no lattice distortion occurs (c), but in a case where its interatomic binding force or repulsive force significantly differs from that of the mother crystal, it distorts the surrounding mother crystal.

第3章 金属結晶中の点欠陥 31



置換原子の場合には、置換原子の大きさによって格子のひずみの程度は異なり、母結晶 (ぼけっしょう)の原子より大きい原子であれば図 3.5(a)のように周囲の格子を押し拡げ、 小さければ空孔と同様に周囲から押される(b). 母結晶と同じ大きさの原子であれば、格子 のひずみは生じないが(c)、原子間結合力や斥力が母結晶原子といちじるしく異なる場合に は、周囲の母結晶格子をひずませる.

" (page 31)

b "Shigeyasu Koda, Revised Introduction of Metal Physics, December 25, 1998, pages 63 to 65" cited in the notice of the reasons for refusal on May 7, 2018 has the following description:

4・3・2 不純物の存在状態 "4.3.2 State of impurities

16 / 40

ところで、この不純物原子の純金属中へのはいり方であるが、これには、溶け込んでいる(固溶している)ときと、そうでないときの二様がある。

Incidentally, regarding a manner of insertion of this impurity atom into a pure metal, there are two manners: being dissolved (solid solution), and not being dissolved.

第1の固溶しているときのはいり方を結晶構造上からみると、不純物原子が結晶格子の間にはいり込む場合と、格子点にある原子と置き換わってはいり込む場合の2種がある。前者を、侵入型(interstitial)、後者を置換型(substitutional)という。(図4・3)。 When the inserted state of the former solid solution is observed in terms of a crystal structure, there are two types: a case of an impurity atom being inserted between a crystal lattice; and a case of an impurity atom being replaced with an atom at a grid point. The former is referred to as interstitial, the latter is referred to as substitutional. (Figure 4.3).

(a) 侵入型 (a) Interstitial

(b)置換型 (b) Substitutional

図4・3 2種の固溶のしかた Figure 4.3 Two manners of solid solution

4.3.2 不純物の存在状態

ところで、この不純物原子の純金属中へのはいり方であるが、これには、溶 け込んでいる(固溶している)ときと、そうでないときの二様がある.

第1の固溶しているときのはいり方を結晶構造上からみると,不純物原子が

結晶格子の間にはいり込む 場合と,格子点にある原子 と置き換わってはいり込む 場合の2種がある.前者を, 侵入型 (interstitial),後者 を置換型 (substitutional)



" (page 63)

"

# 第4章 実在の金属の構造

"Chapter 4 Structure of existing metal

侵入型に不純物原子がはいるときは、もともと結晶格子間には、そうすきま がないから、当然不純物原子の大きさが小さい場合に限定される。そのため、 侵入型にはいりうる可能性のある原子は、H(0.46Å)、B(0.97Å)、C (0.77A)、N(0.71A)、O(0.60A)に限られる。かっこ内は原子半径を示 す。大体1Å以下が基準で、それ以上のものは侵入型に固溶し得ない\*。

When an impurity atom is inserted into an interstitial-type, there is an insufficient gap between crystal lattice in the first place. Thus it is limited to a case where the size of impurity atom is small. Therefore, an atom insertable into an interstitial-type is limited to  $H(0.46\text{\AA})$ ,  $B(0.97\text{\AA})$ ,  $C(0.77\text{\AA})$ ,  $N(0.71\text{\AA})$ , and  $O(0.60\text{\AA})$ . The values in parentheses show atomic radii. In general, the criterion is not more than 1Å. An atom larger than the criterion cannot dissolve into an interstitial-type\*.

実際の結晶構造で、不純物原子が侵入型にはいる位置については、最もすき まの大きい場所と考えるのが自然であり、特殊の場合を除いてそうなっている と考えてよい。面心立方結晶ならば、図4・4(a)の白丸の位置が最もあい ている場所で、そこは格子点にある金属原子でできる八面体(octahedra)の中 心になっている。つぎにすきまのある場所は、図(b)の四面体(tetrahedra) の中心である。体心立方結晶では図4・5(a)の四面体位置が最もすきまの ある場所で、ついで図(b)の八面体位置となる。 Regarding a position where an impurity atom is inserted into an interstitial-type in an actual crystal structure, it is natural to think the position as a site with the largest gap, and actually the position is the site with the largest gap, except for special cases. If the crystal structure is a facecentered cubic crystal, the position of the white circles of Figure 4.4(a) is a site with the largest gap, which forms a center of octahedra defined by metal atoms in grid points. A position with the second largest gap is a center of the tetrahedron of Figure (b). If the crystal structure is a body-centered cubic crystal, the tetrahedron of Figure 4.5(a) is a site with the largest gap, and the second largest gap may be found in an octahedral position of Figure (b).

面心立方結晶の $\gamma$ -Feにおいて炭素原子は八面体位置に侵入しているが、体 心立方結晶の $\alpha$ -Feでは、一番すきまの大きい四面体位置にはいらず、八面体 位置にはいる。その結果、体心立方の一つの軸が伸ばされて、体心正方構造を 呈する。 In a face-centered cubic crystal of  $\gamma$ -Fe, a carbon atom is inserted into an octahedral position. In a body-centered cubic crystal of  $\alpha$ -Fe, it is not inserted into a tetrahedral position with the largest gap, but into an octahedral position. As a result, one axis of the body-centered cubic is extended to exhibit a body-centered tetragonal structure.

置換型に不純物原子がはいる場合、母体金属原子と大きさが違うと、図4・ 6のように結晶格子がひずまされる。また、侵入型のときは、もともとむりな ので、つねにまわりがひずむ。たとえば、Fe中に固溶した炭素、窒素は結晶 格子をひずませる。ただし、Fe中の水素は、水素の原子半径がきわめて小さ いうえに、水素イオン(陽子)になっていると思われるので、格子をひずませ ない。 In a case of an impurity atom being inserted into a substitutional, a difference in size from a mother metal atom results in a distortion of the crystal lattice as shown in Figure 4.6. Further, in an interstitial-type, it is inherently infeasible, and thus the surroundings are always distorted. For example, carbon and nitrogen dissolved into Fe distort the crystal lattice. But it seems that hydrogen in Fe does not distort a lattice, since an atomic radius of hydrogen is extremely small and it becomes a hydrogen ion (proton).

図4・4 面心立方結晶で侵入型原子のはいりやすい位置 Figure 4.4 A position tends to include an interstitial-type atom in a face-centered cubic crystal

黒丸が金属原子、白丸は侵入可能な位置(Barrett) A black circle is a metal atom, and a white circle is an insertable position (Barrett)

図4・5 体心立方結晶で侵入型原子のはいりやすい位置 Figure 4.5 A position tends to include an interstitial-type atom in a body-centered cubic crystal

黒丸は金属原子、白丸は侵入可能な位置(Barrett) A black circle is a metal atom, and a white circle is an insertable position (Barrett)

\*放射線損傷を受けた金属では金属原子が格子間にはいることがある。

\* Metal subjected to radiation damage sometimes includes a metal atom in a lattice.

という (図 4.3).

侵入型に不純物原子がはいるときは、 もともと結晶格子間には、 そうすき まがないから、 当然不純物原子の大きさが小さい場合に限定される. そのた め、 侵入型にはいりうる可能性のある原子は、 H (0.46 Å), B (0.97 Å), C (0.77 A), N (0.71 A), O (0.60 A) に限られる. かっこ内は原子半径を示 す. 大体 1 Å 以下が基準で、それ以上のものは侵入型に固溶し得ない\*.

実際の結晶構造で、不純物原子が侵入型にはいる位置については、最もすき



図 4・4 面心立方結晶で侵入型原子のはいりやすい位置 黒丸が金属原子,白丸は侵入可能な位置 (Barrett) まの大きい場所と考えるのが 自然であり,特殊の場合を除 いてそうなっていると考えて よい.面心立方結晶ならば, 図 4·4 (a)の白丸の位置が 最もあいている場所で,そこ は,格子点にある金属原子で

できる八面体 (octahedra) の中心になっている. つぎにすきまのある場所は,

図 (b) の四面体(tetrahedra) <sub>a√3/2</sub> の中心である.体心立方結晶 では 図 4·5 (a) の 四面体位 置 が 最 もすきまのある 場所 で, ついで図 (b) の八面体 位置となる.



面心立方結晶の r-Fe にお いて炭素原子は八面体位置に

図 4.5 体心立方結晶で侵入型原子のはいりやすい位置 黒丸は金属原子,白丸は侵入可能な位置 (Barrett)

侵入しているが,体心立方結晶の α-Fe では,一番すきまの大きい四面体位置 にはいらず,八面体位置にはいる.その結果,体心立方の一つの軸が伸ばされ て,体心正方構造を呈する.

置換型に不純物原子がはいる場合,母体金属原子と大きさが違うと,図 4.6 \* 放射線損傷を受けた金属では金属原子が格子間にはいることがある.

" (page 64)

#### 4・3 純金属中の不純物 "4.3 Impurities in pure metal

"

図4・6 置換型不純物原子による結晶格子のひずみ Figure 4.6 Distortion of crystal lattice by a substitutional impurity atom

第2の固溶しないときは当然別のもの——術語を用いれば、別の相(phase)として純金属の地(じ)の中に出ることになる。このときな原子状ででるのではないから、不純物原子が若干集まったかたまりか、あるいは、不純物原子と他の元素との化合物のかたまりとして出る。このような集まりを介在物あるいは夾雑物(inclusion)と呼ぶ。多結晶質の金属では、介在物が粒界に出やすい。粒界に薄膜状に出る性質の不純物が存在すると、粒界をもろくする。Cu中のBiなどその著しい例である。 Secondly, if not dissolved, it appears in a matrix of a pure metal as the other one - using academic terms, the other phase. It does not appear at the atomic level, but appears as a lump in which several impurity atoms are gathered, but otherwise appears as a lump of a compound of an impurity atom and the other element. Such a lump is referred to as an inclusion. In a polycrystalline metal, the inclusion tends to appear in a grain boundary. If impurities are present filmily in a grain boundary, the grain boundary becomes brittle. Bi in Cu is a notable example.

のように結晶格子がひずまされる.また,侵入型のときは,もともとむりなの で,つねにまわりがひずむ.たとえば, Fe 中に固溶した炭素,窒素は結晶格 子をひずませる.ただし, Fe 中の水素は,水素の原子半径がきわめて小さい うえに,水素イオン(陽子)になっていると思われるので,格子をひずませな い.



図 4.6 置換型不純物原子による結晶格子のひずみ

第2の固溶しないときは当然別のもの――術語を用いれば,別の相 (phase) として純金属の地(じ)の中に出ることになる.このときは原子状で出るのでは ないから,不純物原子が若干集まったかたまりか,あるいは,不純物原子と他 の元素との化合物のかたまりとして出る.このような集まりを介在物あるいは 交雑物 (inclusion) と呼ぶ.多結晶質の金属では,介在物が粒界に出やすい. 粒界に薄膜状に出る性質の不純物が存在すると,粒界をもろくする.Cu中の Bi などその著しい例である.

" (page 65)

The above descriptions a and b, in particular the description in the column of "b. atom between lattice" and "c. substitutional atom" of the above a (including Figure 3.2 and Figure 3.3) and the description of page 63 to page 64, line 6 of the above b (including Figure 4-3) support the presence of the matters shown in the above E-1 and the above E-2 as common technical knowledge as of the filing of the present application.

(B) Grounds for E-3

a Japanese Unexamined Patent Application Publication No. 2005-336555 cited in the notice of the reasons for refusal dated May 7, 2018 has the following description:

# "[0020]

Mg powder (average particle diameter: 800  $\mu$ m) and Ca powder (average particle diameter: 2 mm) were fed to a container for a chrome steel-made planetary ball mill apparatus (Volume 45 ml) at a molar ratio of 2:1 together with a chrome steel-made ball (7 mm $\phi$  \* 22), and subjected to mechanical alloying (MA) for 80 hours by a planetary ball mill apparatus at a room temperature under an Ar gas atmosphere. [0021]

The weight ratio of a ball to a sample was set to 30:1, and a rotation number of the planetary ball mill apparatus was set to 600 rpm. The powders in a container were analyzed by X-ray diffraction (XRD), which suggested the production of CaMg2. The CaMg2 and V powder (average particle diameter: 50 µm) were fed to a container for a chrome steel-made planetary ball mill apparatus (Volume 45 ml) at a molar ratio of 1:3 together with chrome steel-made balls (7 mm $\phi$  \* 22), and subjected to MA for 1 to 40 hours by use of the planetary ball mill apparatus at room temperature under an Ar gas atmosphere. The weight ratio of a ball to a sample was set to 30:1, and a rotation number of a planetary ball mill apparatus was set to 600 rpm. The alloy powder thus obtained was analyzed by XRD. The result is shown in Figure 1. In Figure 1, symbol 1 represents an XRD pattern of a sample before MA, symbol 2 represents an XRD pattern of a sample for which MA was implemented for one hour, symbol 3 represents an XRD pattern of a sample for which MA was implemented for two hours, symbol 4 represents an XRD pattern of a sample for which MA was implemented for five hours, and symbol 5 represents an XRD pattern of a sample for which MA was implemented for ten hours. [0022]

The peaks of (011) surface, (002) surface, and (112) surface corresponding to the body-centered cubic lattice structure of V were shifted to a lower angle with increasing MA time, and the peak attributed to CaMg2 was being diminished. Thus it can be seen that a part of V was gradually replaced with Mg and Ca, which have a larger atomic radius, while maintaining the body-centered cubic lattice structure."

"[FIG. 1]



"

b Japanese Unexamined Patent Application Publication No. 2009-218196 cited in the notice of the reasons for refusal dated May 7, 2018 has the following description: "[0058]

Examples and Comparative Examples

Example 1 relied on the production method of the present invention. <u>PtNi/C</u> <u>alloy electrode material with a metal content of 40 weight% was produced</u>. The process is shown in Figure 1. The production step is illustrated in further detail as set forth below.

[0069]

Figure 3 is a powder X-ray diffraction pattern (XRD) of an electrode material produced in Example 1, and Comparative Examples 1 to 3. [0070]

Example 1 used sodium acetate as an additive. <u>The commercially available</u> catalyst (40 weight% Pt/C(Johnson & Matthey)) at the lowest part was used for comparison under the same measurement conditions. The largest difference was peak shifts of Pt(111) and Pt(220) to higher 2 $\theta$  values. This is because the atomic size of Ni is about 11% smaller than that of Pt. In producing a substitution-type solid solution, a lattice constant is decreased by Ni having a smaller size, thereby shifting to a further high 2 $\theta$  value in an XRD measurement result. Through this experiment, the degree of alloying may be estimated. Specifically, increased variation of  $2\theta$  value means further high alloying. As a result, an electrode material prepared through a production step of Example 1 shows a very high peak shift compared to a material of commercially available catalyst (40 weight% Pt/C (Johnson & Matthey)) for comparison. Thus a level of alloying is very high."

"[FIG. 3]





In view of the above descriptions a and b, in particular, "the peaks of (011) surface, (002) surface, and (112) surface corresponding to the body-centered cubic lattice structure of V were shifted to a lower angle with increasing MA time, and the peak attributed to CaMg2 was diminished. Thus it can be seen that a part of V was gradually replaced with Mg and Ca, which have a larger atomic radius, while maintaining the body-centered cubic lattice structure." of the above a, and "the largest difference was peak shifts of Pt(111) and Pt(220) to higher 2 $\theta$  values. This is because the atomic size of Ni is about 11% smaller than that of Pt. In producing a substitution-type solid solution, a lattice constant is decreased by Ni having a smaller size, thereby shifting to a further high 2 $\theta$  value in an XRD measurement result." of the above b, it can be said that the presence of the matter shown in the above E-3 is supported as a matter of common technical knowledge as of the filing of the present application.

(C) Grounds for E-4

a "Kagaku Binran Fundamental Revised 5th edition, February 20, 2004, II-page 887" cited in the notice of the reasons for refusal on May 7, 2018 has the following description:

Li 1.52	Be 1.11		最長	短原子間 そこの単位	間距離の当 2はÅ(1	≦分を示す Å =0.1 m	~(2 種あ n=10 <sup>-10</sup>	る場合に m).	は短いほ	うの値を	とってあ	る).		
Na 1.86	Mg 1.60	AI 1.43												
K 2.31	Ca 1.97	Sc 1.63	Ti 1.45	V 1.31	Cr 1.25	Mn 1.12	Fe 1.24	Co 1.25	Ni 1.25	Cu 1.28	Zn 1.33	Ga 1.22		
Rb 2.47	Sr 2.15	Y 1.78	Zr 1.59	Nb 1.43	Mo 1.36	Tc 1.35	Ru 1.33	Rh 1.35	Pd 1.38	Ag 1,44	Cd 1.49	In 1.63	Sn 1.41	Sb 1.45
Cs 2.66	Ba 2.17	La 1.87	Hf 1.56	Та 1,43	W 1.37	Re 1.37	Os 1.34	Ir 1.36	Pt 1.39	Au 1.44	Hg 1.50	Tl 1.70	Pb 1.75	Bi 1.56
La 1.87	Ce 1,83	Pr 1.82	Nd 1.81	Pm 1.80	Sm 1.79	Eu 1.98	Gd 1.79	Тb 1.76	Dy 1.75	Но 1.74	Er 1.73	Tm 1.72	Yb 1.94	Lu 1.72
Ac 1.88	Th 1.80	Pa 1.61	U 1.38	Np 1.30	Pu 1.6	Am								

表 16.36 金属結合半径 Table 16.36 Metal bonding radius

最短原子間距離の半分を示す(2種ある場合には短いほうの値をとってある)。

Show a half of shortest interatomic distance (take a shorter value in a case where there are two kinds)

長さの基準はÅ (1Å=0.1 n m=10<sup>-10</sup>m)。 The standard of length is angstroms (1 Å=0.1 nm=10<sup>-10</sup> m)

" (II-page 887)

b "Consistent approaches to van der Waals radii for the metallic elements, Z. Kristallogr., 2009, Vol. 224, pp. 375-383" cited in the notice of the reasons for refusal on May 7, 2018 has the following description:

Table 1. var	n der Waals	radii (A) of	metal	atoms.
	Contract Contractor The Pro-	and the second second		C 101-

a: Derived from single covalent radii in Ref. [8];b: Derived from Allinger's van der Waals radii in Ref. [8];c: Derived from bond valence parameters in Ref. [23] except where noted otherwise.

Element	Bondi [4]	Allinger [8]	Zefirov [9]	Batsanov [10]	Datta [11]	Hu [12]	This work a	This work b	This work c
Li	1.82	2.55	2.2	2.2		1.75	1.99	2.21	2.14
Na	2.27	2.70	2.3	2.4		1.84	2.33	2.34	2.38
5	2.75	3.09	2.7	2.8		2.05	2.79	2.68	2.52
tb		3.25	2.8	2.9		2.16	2.92	2.81	2.61
s	10.00	3.44	2.9	3.0	10000	2.22	3,11	2.98	2.75
Cu	1.4	2.26	1.9	2.0	1.92	1.86	1.96	1.96	1.96
Ag	1.72	2.43	2.0	2.1	2.10	2.03	2.10	2.10	2.11
.u	1.66	2.43	2.0	2.1	2.10	2.17	2.10	2.10	2.14
le	10.300553	2.23	1.9	1.9		2.05	1.64	1.93	1.69
Ag	1.73	2.43	2.0	2.2		2.05	1.93	2.10	2.00
a		2.81	2.4	2.4		2.21	2.50	2.43	2.27
r		3.00	2.6	2.55		2.24	2.68	2.60	2.42
la	Sources and the second	3.07	2.6	2.7		2.51	2.74	2.66	2.59
'n	1.39	2.29	1.9	2.1	1.98	2.10	2.01	1.98	2.01
ď	1.62	2.50	2.1	2.2	2.17	2.30	2.17	2.17	2.18 <sup>d</sup>
Ig	1.70	2.53	2.0	2.05	2.24	2.09	2.20	2.19	2.23
c		2.61	2.2	2.3	2.12	2.16	2.20	2.26	2.15
		2.71	2.3	2.4	2.29	2.19	2.38	2.35	2.32
a		2.78	2.3	2.5	2,45	2.40	2.45	2.41	2.43
1		2.15	1.8	1.8		1.47	1.64	1.86	1.68
d.		2.36	2.0	2.1		2.11	2.01	2.04	1.92
ia	1.87	2.46	2.1	2.1		2.08	2.01	2.13	2.03
n	1.93	2.64	2.2	2.2		2.36	2.26	2.29	2.21
F	1.96	2.59	2.2	2.2		2.35	2.31	2.24	2.27
ĩ		2.39		2.15	2.07	1.87	2.08	2.07	2.11
'r		2.54		2.3	2.19	1.86	2.21	2.20	2.23
If		2.53		2.25	2.19	2.12	2.20	2.19	2.23
li	2.10	2.29		2.1		2.07	1.93	1.98	1.93
ie		2.44		2.1		2,15	1.98	2.11	2.05
in	2.17	2.59		2.25		2.33	2.16	2.24	2.23
'b	2.02	2.74		2.3		2.32	2.30	2.37	2.37
t.		2.29		2.05	2.06	1.79	1.98	1.98	2.07
Vb		2.43		2.15	2.17	2.07	2.10	2,10	2.18
a		2.43		2.2	2.18	2.17	2.10	2.10	2.22
15	1.85	2.36		2.05		2.06	1.97	2.04	2.08
b		2.52		2.2		2.25	2.17	2.18	2.24 <sup>e</sup>
li		2.66		2.3		2.43	2.28	2.30	2.38
Ϋ́Τ		2.25		2.05	2.06	1.89	1.93	1.95	2.06
Ao		2.39		2.1	2.16	2.09	2.05	2.07	2.17
V		2.39		2.1	2,18	2.10	2.06	2.07	2.18
An		2.24		2.05	2.04	1.97	1.93	1.94	2.05
c		2.36		2.05	2.16	2.09		2.04	2.16
e		2.37		2.05	2.16	2.17	2.04	2.05	2.16
e		2.23		2.0	2.02	1.94	1.92	1.93	2.04
0		2.23		2.0	1.91	1.92	1.92	1.93	2.00
li	1.63	2.22		2.0	1.98	1.84	1.91	1.92	1.97
tu		2.34		2.05	2.17	2.07	2.00	2.03	2.13
th		2.34		2.0	2.04	1.95	2.01	2.03	2.10
b	1.63	2.37		2.05	2.09	2.03	2.04	2.05	2.10
)s		2.35		2.0	2.17	2.16	2.02	2.04	2.16
r.	The second se	2.36		2.0	2.09	2.02	2.02	2.04	2.13
1	1.72	2.39		2.05	2.09	2.09	2.05	2.07	2.13
°0						2.29	2.29	2.24	2.49
M						2.36		2.17	
T						2.56		3.15	
ta	1			1.1		2.43		2.83	0.000
h	100			2.4		2.37	2.43	2.37	2.45
J	1.86			2.3		2,40	2.38	2.18	2.41

d:  $R_0$  of 1.875 with B = 0.37 Å for Cd(II)–O bonds was used in the calculations, see Palenik, G. J.: Can.: J. Chem. 84 (2006) 99; e:  $R_0$  values 1.955/1.912 Å with B = 0.37 Å for Sb(III)/Sb(V)–O bonds were applied, see Palenik, R. C.; Abboud, K. A.; Palenik, G. J.: Inorg. Chim. Acta. 358 (2005) 1034.

"(page 378)

(Body's translation: Table 1 van der Waals radii (Å) of metal elements)

Both metallic bond radius and van der Waals radius are obviously barometers showing a size of atom. According to "Table 16.36" of the above a, metallic bond radius is 1.63Å for In and 1.38Å for Pd. Thus In is larger than Pd. Further, according to the above b, van der Waals radii might have differences in numerical value depending on authority, the trend is the same. Whatever authority you rely on, In is greater than B Therefore, it can be said to be evident from these descriptions that the matter or Pd. shown in the above E-4 was present as a matter of common technical knowledge as of the filing of the present application.

3 Appellant's allegation

(1) Written Opinion dated August 14, 2018

A Appellant argues in the written opinion dated August 14, 2018 as set forth below:

"Appellant submitted the following reference document as a document showing that In can be present as an interstitial-type impurity atom in Pd crystal lattice.

Reference Material 1: Pd-In intermetallic alloy nanoparticles: highly selective ethane dehydrogenation catalysts, Catal. Sci. Technolo., 2016. 6, 6965

Reference Material 2: Surface Structures of In-Pd intermetallic compounds. II. A theoretical study, The Journal of Chemical Physics 141, 084703 (2014)

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As aforementioned, the reasons for refusal directed to the enablement requirement as pointed out will be overcome on the basis of Reference Materials 1 and 2 that can establish the fact that not a structure of In being replaced with a precious metal atom forming a unit lattice, but a structure of In being inserted into a gap between precious metal atoms forming a unit lattice was actually realized."

B However, the allegation based on Reference Materials 1 and 2 cannot establish the fact that "said In is present as an interstitial-type atom between Pd atoms forming a unit lattice of said Pd" has been realized, as specifically considered respectively in the following C and D.

C Regarding allegation based on Reference Material 1

(A) Appellant alleges that

"In a figure showing a crystal structure of Pd3In of Fig. 1b) of Reference Material 1 (the below Figure 1), you may find that In (purple sphere) is located in a unit lattice of Pd (gray sphere) in a part surrounded by a red square.

[Figure 1]



Specifically, in an A-B crystal lattice structure consisting of atom A and atom B, it is not necessary for B to have a smaller atomic radius than A to form a structure where B is inserted into a unit lattice of A. Even if B has a larger atomic radius than A, a sufficient distance between the atoms A is maintained for the inclusion of B."

Therefore, consideration is given hereinafter.

(B) The whole disclosure of Fig. 1 of Reference Material 1 is set forth as below: Thus it is supposed that a large sphere is In and a small sphere is Pd in the above Figure 1.



Further, Fig. 1 of Reference Material 1 has an explanation as set forth below: "Fig. 1 a) In-Pd phase diagram at 600°C adapted from Okamoto et al. 21 and b) crystal structure of Pd and different Pd-In intermetallic compound phases. 22-26".

(C) The above Fig. 1 a) describes a phase diagram (state diagram) of In-Pd alloy at 600°C. According to the phase diagram, as the phase shifts from a phase of Pd 100% at the right end to the left side, the In ratio is increased, and reaches a state of 100% In at the left end. Further, in accordance with the increase in a proportion of In from a single phase of 100% Pd, 6 kinds of intermetallic compounds are sequentially produced to become a liquid state by decreasing a melting point at the vicinity of 100% In at a left end. Looking into this phase diagram, as the ratio of In to be dissolved is increased from a single phase of Pd at the right end, the phase shifts to a state where two phases of Pd and Pd3In are mixedly present. As the ratio of In is further increased, the phase shifts to a state where two phase of Pd3In, and the ratio of In is further increased, the phase shifts to a state where two phase of Pd3In are mixedly present.

Here, the crystal structure of intermetallic compound Pd3In is shown in the second figure from the upper left stage of b) (meaning Figure 1 shown by Appellant). It can be seen that a rectangular region partitioned by 12 thin lines (four lines constituting a top face of a cuboid, four lines constituting a bottom face of the cuboid, and four lines connecting the top face and the bottom face) represents a unit lattice of the intermetallic compound Pd3In. The above rectangular region is a unit lattice of the intermetallic compound Pd3In, which can be seen from the inclusion of 12 Pd and 4 In at an atomic ratio of Pd and In of 12:4=3:1 (calculated as 1/4 atom if an atom is on a side of a rectangular solid, 1/2 atom if an atom is on a face of the solid, 1 atom if an atom is in the solid) when calculating the numbers of Pd and In included in the rectangular region.

Specifically, Figure 1 shown by Appellant shows a unit lattice of the intermetallic compound Pd3In. Thus in Figure 1, In atom is not present as an interstitial-type atom in a unit lattice of Pd, but is present as a regular atom forming a unit lattice of an intermetallic compound Pd3In in a predetermined position of the unit lattice.

(D) Consequently, it can be said that Pd atom (small sphere) in the above Figure 1 is not a "Pd atom forming a unit lattice of Pd" but a Pd atom forming a unit lattice of an intermetallic compound of "Pd3In". Therefore, the In atom of the above Figure 1 is not present as an interstitial-type atom between Pd atoms forming a unit lattice of Pd.

Therefore, the above Figure 1 does not disclose a technical matter corresponding to the matter that "said Group 13 element is present as an interstitial-type atom between precious metal atoms forming a unit lattice of said precious metal" as specified in Present Invention 1.

(E) Therefore, the Appellant's allegation based on Reference Material 1 does not establish the fact that the matter that "said In is present as an interstitial-type atom between Pd atoms forming a unit lattice of said Pd" has been realized, nor has the reason for refusal according to the enablement requirement been overcome.

D Regarding allegation based on Reference Material 2

(A) Appellant alleges that

"Further, in Table 3 (the following Figure 2) of Reference Material 2 disclosing the structure of In and Pd, you may note that In atom (blue sphere) is present in a square consisting of Pd (gray sphere).

[Figure 2]



Therefore, consideration is given hereinafter.

(B) In the above Figure 2, a large sphere is believed to be an In atom and a small sphere is believed to be a Pd atom. Thus it is believed that "In atom is present in a square consisting of Pd" as Appellant alleges means a figure of c=33% (the upper right column, in which one In atom is present in a square defined by Pd) or a figure of c=67% (the lower central column, in which two In atoms are present in a square defined by Pd).

(C) Incidentally, as shown in the aforesaid 2(2)A(A), taking into account the fact that a minimum unit in a steric lattice with a constituent molecule and an atom regularly arranging in three dimension so as to have a certain periodicity is referred to as "unit lattice", consideration is given as to which part corresponds to a unit lattice of Pd in the above Figure 2.

The following Figure 2' indicates two squares defined by Pd for convenience by writing a dashed-dotted line and a dotted line by the body for the case of c=11% of the above Figure 2.

In this Figure 2', a minimum unit of periodicity is a square of dotted line. Thus the square of the dotted line corresponds to the unit lattice of Pd. On the other hand, a dashed-dotted square is not a minimum unit, and thus is not a unit lattice of Pd.

FIG. 2'

"

ー点鎖線の四角形 Square with dash-dotted lines Pdの単位格子ではない Not unit lattice of Pd

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点線の四角形 Square with dotted lines Pdの単位格子 Unit lattice of Pd



(D) Further, the figure of c=33% in the above Figure 2 corresponds to one in which one of two Pd atoms, which were present so as to be surrounded by a square of dash-dotted lines in Figure 2', is replaced with In atom. Further, the figure of c=67% corresponds to one in which two Pd atoms, which were present so as to be surrounded by a square of dash-dotted lines in Figure 2', are both replaced with In atoms.

Therefore, the In atom of the figure of c=33% and the figure of c=67% in the above Figure 2 is not present as an interstitial-type atom between Pd atoms forming a unit lattice of Pd, but it should rather be said that the In atom is present by replacing a Pd atom forming a unit lattice of Pd.

(E) Therefore, the above Figure 2 does not disclose the technical matter corresponding to the matter that "said Group 13 element is present as an interstitial-type atom between precious metal atoms forming a unit lattice of said precious metal" as specified in Present Invention 1.

(F) Therefore, the Appellant's allegation based on Reference Material 2 does not establish the fact that the matter that "said In is present as an interstitial-type atom between Pd atoms forming a unit lattice of said Pd" has been realized, nor has the reason for refusal according to the enablement requirement been overcome.

E As per the consideration of the above C and D, should the written opinion dated August 14, 2018 be taken into account, the reason for refusal according to the enablement requirement has not been overcome.

### (2) Allegation in Appeal Brief

A Appellant presents the following allegation in the Appeal Brief as a counterargument against reasons for refusal under Article 29(1)(iii) and (2) of the Patent Act and Article 36(6)(i) of the Patent Act, which are the reasons of the original decision (For convenience, the body categorizes the counterargument into "Allegation A-1" and "Allegation A-2".)

- Allegation A-1

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"[2] Reasons for refusal 3 and 4 (Novelty and Inventive step)

The invention recited in Claim 1 of the present application has a feature of "the Group 13 element comprises indium (In)". Further, the inventions recited in Claims 7, 14, and 15 of the present application have a similar feature.

However, referring to Figure 1B of the present application (the following Figure 1), it is demonstrated that the Group 13 element 24 is present between precious metal atoms 22 forming a unit lattice 20, and In is definitely shown as a kind of the Group 13 element in the present invention.

Further, according to Figure 5 (Figure 2 below) and evaluation example 2, a diffraction angle  $(2\theta)$  of (111) peak of a catalyst of Example 9 is decreased compared to a diffraction angle  $(2\theta)$  of (111) peak of a catalyst of Comparative Example 3. This shift shows that In and precious metal atom form an alloy or a solid solution. This is because In atom added to a catalyst of Example 9 is inserted into a unit lattice of a catalyst of Example 9, so that a distance between crystal surfaces parallel to each other is increased in a unit lattice of a catalyst of Example 9.

[Figure 1]

本願 図1B The present application Figure 1B



本願 図1B

[Figure 2]

強度/カウント	Strength/count
実施例 9	Example 9
比較例 3	Comparative Example 3
20/角度	20/angle
本願 図 5	The present application Figure 5



Therefore, against the common technical knowledge as shown in Cited Document 7, the present application shows in the examples that In is definitely inserted between precious metal atoms forming a unit lattice. Cited Document 2 does not disclose that In is present between precious metal atoms forming a unit lattice of Pd5Ir.

Further, such an invention embodied is not disclosed in Cited Document 4."

- Allegation A-2

"(3) Reasons for refusal 1 (Article 36(6)(i) of the Patent Act)

As aforementioned, referring to Figure 1B of the present application (the aforesaid Figure 1), it is demonstrated that the Group 13 element 24 is present between precious metal atoms 22 forming a unit lattice 20, and In is definitely shown as a kind of the Group 13 element in the present invention.

Further, according to Figure 5 of the present application (aforesaid Figure 2) and evaluation example 2, as aforementioned, not only does the presence of In simply increase the distance between crystal surfaces parallel to each other, but also the decrease in diffraction angle suggests that In and a precious metal atom form an alloy or a solid solution, as explained in a discussion about novelty and inventive step. Therefore, it is obvious that the In does not replace an atom of crystal lattice in the present invention, but In is present between precious metal atoms forming a unit lattice of a crystal.

Further, as in the written opinion on February 6, 2017, the present invention "simultaneously" reduces a precious metal precursor and a Group 13 precursor so that the Group 13 element is taken into a crystal lattice to be inserted therein simultaneously when the reduced precious metal atom forms a crystal lattice. Thus it is inserted into a crystal lattice. Thus it is obvious that the inventions recited in Claims 1 to 15 of the present application "The insertion of an atom of the Group 13 element into a unit lattice of the crystalline catalyst particle leads to an increase in the distance between crystal surfaces of the crystalline catalyst particle and the lattice constant", solves the problem to be solved by the present invention.

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Therefore, the Applicant submits that the inventions recited in Claims 1 to 15 of the present application solve the problem to be solved by the present invention by In inserted in a crystal lattice, and thus the inventions described in the Detailed Description of the Invention solve the problem to be solved, and the reasons for refusal have been overcome."

B These allegations are not counterarguments against reasons for refusal according to the enablement requirement, but the content of the allegations is associated with whether the matter that "said In is present as an interstitial-type atom between Pd atoms forming a unit lattice of said Pd" can be realized, as considered in the aforesaid 2(3). Therefore, consideration is given hereinafter as to whether or not there is a ground sufficient to find the fact from the above allegation A-1 or the allegation A-2 that the matter that "said In is present as an interstitial-type atoms forming a unit lattice of said Pd" was realized.

C Allegation A-1 can be categorized into the allegation based on Figure 1B of the present application and the allegation based on Figure 5 and the evaluation example 2 of the present application. Consideration is given to the respective allegations in the following.(A) Regarding the allegation based on Figure 1B of the present application

FIG. 1B of the specification of the present application is "a schematic diagram of a unit lattice of a crystalline catalyst particle" (paragraph [0024]). This cannot be a ground for the matter that "said In is present as an interstitial-type atom between Pd atoms forming a unit lattice of said Pd" having been realized, as discussed in the aforesaid 2(3)C.

Further, it is recognized that the other atom actually cannot be inserted into a part where an atom 24 is disposed in FIG. 1B of the specification of the present application, except for the position of a center part of a cuboid of Figure 1B. Specifically, on page 64 of "Shigeyasu Koda, Revised Introduction of Metal Physics, December 25, 1998" as shown in the aforesaid 2(3)E(A)b, it describes that "regarding a position where an impurity atom is inserted into an interstitial-type in an actual crystal structure, it is natural to think the position as a site with the largest gap, and actually the position is the site with the largest gap, except for special cases. If the crystal structure is a face-centered cubic crystal, the position of the white circles of Figure 4.4(a) is a site with the largest gap, which forms a center of octahedra defined by metal atoms in grid points. A position with the second largest gap is a center of the tetrahedron of Figure (b)." Taking this fact and figure 4-4(a) and (b) into account, it is recognized that there is no gap in a position sufficient to accommodate the atom 24, except for the position of a center part of a cuboid of Figure 1B, and actually, the atom 24 may not be inserted into the position.

Therefore, the allegation based on Figure 1(B) of the present application in the Allegation A-1 cannot be a ground for the matter that "said In is present as an interstitial-type atom between Pd atoms forming a unit lattice of said Pd" having been realized.

(B) Allegation based on Figure 5 and the evaluation example 2 of the present application

It can be seen from Figure 5 of the present application that a diffraction angle  $(2\theta)$  of (111) peak of the catalyst of Example 9 is decreased compared to a diffraction angle  $(2\theta)$  of (111) peak of the catalyst of Comparative Example 3 (a shift to a lower angle occurs), as Appellant mentioned in this allegation. Further, this shift suggests that In and precious metal atoms form an alloy or a solid solution. This fact is as per the Appellant's statement in this allegation.

In view of the common technical knowledge shown in E-3 of the aforesaid 2(3)E, however, a peak shift of X-ray diffraction pattern may take place even in a case where the other atom M2 replaces an atom of metal M1 forming a crystal lattice (substitutional type). Therefore, the shift of the diffraction angle  $(2\theta)$  of (111) peak of the catalyst of Example 9 to a lower angle can be a ground for the solid solution of In into Pd5Ir and the increase of lattice constant; however, it is indefinite as to whether the shift might be attributed to the insertion of In into a gap between precious metal atoms forming a unit lattice with a composition of Pd5Ir, and it could otherwise be the replacement of In with precious metal atom forming a unit lattice with a composition of Pd5Ir. Further, in view of the common technical knowledge shown in E-2 of the aforesaid 2(3)E, it is reasonable to understand that In is dissolved by replacing a precious metal atom forming a unit lattice with a composition of Pd5Ir, and as a result, the lattice constant is increased, and the shift to a lower angle occurs, unlike the construction described by this Allegation A-2.

Therefore, the allegation based on Figure 5 and the evaluation example 2 of the present application in the allegation A-1 cannot be a ground for the matter that "said In is present as an interstitial-type atom between Pd atoms forming a unit lattice of said Pd" having been realized.

D Allegation A-2 can be categorized into the allegation based on Figure 1B of the present application, the allegation based on Figure 5 and the evaluation example 2 of the present application, and the other allegation. Thus consideration is given to the respective allegation in the following.

(A) Allegation based on Figure 1B of the present application and the allegation based on Figure 5 and the evaluation example 2 of the present application

These allegations cannot be a ground for the matter that "said In is present as an interstitial-type atom between Pd atoms forming a unit lattice of said Pd" having been realized, similar to the consideration in the above C(A) and (B).

(B) The other allegation

This allegation is summarized that "the present invention 'simultaneously' reduces a precious metal precursor and a Group 13 precursor so that the Group 13 element is taken into a crystal lattice to be inserted therein simultaneously when the reduced precious metal atom forms the crystal lattice". Even if Pd precursor and In precursor are "simultaneously" reduced to form a crystalline catalyst particle, in view of the common technical knowledge of E-1 and E-2 of the aforesaid 2(3)E, it is reasonable to believe that In is not inserted into a gap between Pd atoms forming a unit lattice of Pd, but is replaced with Pd atom forming a unit lattice of Pd.

Therefore, this allegation also cannot be a ground for the matter that "said In is present as an interstitial-type atom between Pd atoms forming a unit lattice of said Pd" having been realized.

E As described above, even if consideration should be given to the allegation in the Appeal Brief, there would be no ground sufficient to find that the matter that "said In is present as an interstitial-type atom between Pd atoms forming a unit lattice of said Pd" has been realized. Thus the reason for refusal according to the enablement requirement has not been overcome.

F Further, the body pointed out a similar matter to the above C and B in the notice of

reasons for refusal on May 7, 2018. Appellant does not at all present any specific counterargument against this point in the written opinion dated August 14, 2018.

## (3) Allegation in the written statement on March 19, 2018

A In the written statement on March 19, 2018, Appellant presented a counterargument against the matter described in the reconsideration reports made to the JPO Commissioner in the procedure of reconsideration by examiners before appeal proceedings as set forth below: "The present invention adds boron for the increase of activity of Pd-Ir. Figure 1 shows that boron may be located in a Pd lattice.

Here, in place of boron, the same Group 13 elements of Al, Ga, In, and Tl may be selected. Boron-series elements such as B and In have a feature of a small ionic (atomic) radius. Therefore, the examiner's point of 'In with a large atomic radius cannot be inserted into a unit lattice of Pd' in the procedure of reconsideration by examiners before appeal proceedings cannot be acceptable.".

B This allegation is not a counterargument against reasons for refusal according to the enablement requirement, but the content of the allegation is associated with whether the matter that "said In is present as an interstitial-type atom between Pd atoms forming a unit lattice of said Pd" can be realized, as considered in the aforesaid 2(3). Therefore, consideration is given hereinafter as to whether or not there is a ground sufficient to find the fact from this allegation that the matter that "said In is present as an interstitial-type atom between Pd atoms forming a unit lattice of said Pd" was realized.

C In view of the common technical knowledge of E-2 of the aforesaid 2(3)E, in a case where boron (B) is used as the Group 13 element, as per the Appellant's allegation, it is feasible to insert it into a gap between Pd atoms forming a unit lattice of Pd.

However, according to the common technical knowledge of E-4 of the aforesaid 2(3)E, the size of an In atom is larger than that of B atom. Thus the matter that "Boronseries element such as B and In has a feature of a small ionic (atomic) radius" as Appellant alleges is not consistent with the common technical knowledge. Therefore, the aforesaid allegation based on the matters is not acceptable.

D Further, the written statement describes the comparison of ionic radius between Li and B as set forth below:

\*Boron族元素=B,Al,Ga,In,Tlであり イオン(原子)半径が小さい。

(イオン半径B 0.023nm < Li 0.088nm)

\*Boron族元素=B、AI、Ga、In、TIでありイオン(原子)半径 が小さい。 \*Boron series elements= B, Al, Ga, In, Tl having a smaller ionic (atomic) radius

(イオン半径B 0.023 nm<L i 0.088 nm) (ionic radius B 0.023 nm < Li 0.088 nm)</p>

However, Li is an element irrelevant to the present invention. Thus it is indefinite as to how such comparison of ionic radius between Li and B is related to the present invention. Further, the reference of the numerical values of the ionic radii is indefinite. Therefore, this description does not have any impact at all on the determination about whether or not the matter that "said In is present as an interstitial-type atom between Pd atoms forming a unit lattice of said Pd" can be realized.

E Therefore, even if consideration should be given to the allegation in the written statement on March 19, 2018, there would be no ground sufficient to find that the matter that "said In is present as an interstitial-type atom between Pd atoms forming a unit lattice of said Pd" has been realized. Thus the reason for refusal according to the enablement requirement has not been overcome.

F Further, the body pointed out a similar matter to the above C and E in the notice of reasons for refusal on May 7, 2018. Appellant does not at all present any specific counterargument against this point in the written opinion dated August 14, 2018.

No. 5 Closing

As in the foregoing, the Detailed Description of the Invention of the specification of the present application does not conform to the enablement requirement with respect to Present Invention 1, nor does the Detailed Description of the Invention conform to the requirement of Article 36(4)(i) of the Patent Act.

Therefore, the present application should be rejected without considering whether the Detailed Description of the Invention of the specification of the present application conforms to the requirement of Article 36(4)(i) of the Patent Act with respect to Present Inventions 2 to 15.

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

November 16, 2018

Chief administrative judge: Administrative judge: IKEFUCHI, Ryu TSUJI, Kosuke

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Administrative judge: KAMEGAYA, Akihisa