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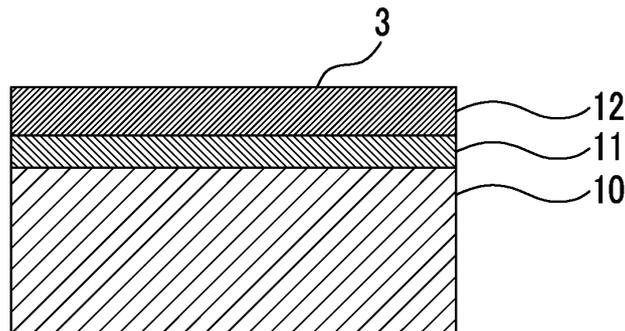
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(54) **COATING STRUCTURE, IMPELLER, COMPRESSOR, METAL PART MANUFACTURING METHOD, IMPELLER MANUFACTURING METHOD, AND COMPRESSOR MANUFACTURING METHOD**

(57) Said coating structure is provided with: a chemical conversion layer (11), which is formed by chemical conversion coating so as to cover the surface of an impeller body (10) obtained from a magnesium alloy that

contains magnesium as the main component and which has a film thickness within a previously determined range; and a plating layer (12) formed so as to cover the chemical conversion layer (11).

FIG. 2



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Description

Technical Field

5 **[0001]** The present invention relates to a coating structure, an impeller, a compressor, a metal part manufacturing method, an impeller manufacturing method, and a compressor manufacturing method.

Background Art

10 **[0002]** In order to reduce weights of members configuring various types of machines and the like, such as an engine and a turbine, the material of the members has been switched from an aluminum alloy to a magnesium alloy.

[0003] In a case where the members are formed of a magnesium alloy, the amount of corrosion increases compared to a case where the member are formed of an aluminum alloy. Therefore, in order to enhance corrosion resistance of a base material made of a magnesium alloy, a surface of the base material is covered by performing chemical conversion treatment or the like. Moreover, the surface of the base material is sometimes coated with a resin.

15 **[0004]** However, for example, in a case of forming a part of an engine performing exhaust gas recirculation (EGR) with a magnesium alloy, the chemical conversion treated layer or resin coating is sometimes affected by moisture condensed in an exhaust gas recirculation step. As a result, erosion or corrosion occurs in the part.

[0005] Therefore, in regard to parts formed of a magnesium alloy, the corrosion resistance is desired to be further enhanced.

20 **[0006]** For example, PTL1 discloses a configuration in which a base material made of a magnesium alloy is subjected to nickel-based plating. When a surface is subjected to plating, compared to the chemical conversion treatment or the resin coating, higher corrosion resistance can be acquired.

25 **[0007]** Here, in the configuration disclosed in PTL1, before the base material is subjected to the nickel-based plating treatment, pretreatment such as chemical etching is performed. Such pretreatment is performed in order to enhance adhesion between a base material and a plating film.

Citation List

30 Patent Literature

[0008] [PTL1] Japanese Unexamined Patent Application Publication No. 2003-73843

Summary of Invention

35 Technical Problem

[0009] Incidentally, in regard to a magnesium alloy forming the base material, in order to further improve the strength, the composition of the magnesium alloy is changed by adding an additive, or the like. However, depending on the component and the like of the additive added to the magnesium alloy in order to enhance the strength, even though pretreatment such as chemical etching is performed, there are cases where sufficient adhesion between a base material and a plating film cannot be acquired.

40 **[0010]** An object of the present invention is to provide a coating structure in which adhesion between a base material made of a magnesium alloy and a plating layer made of a nickel-based alloy is enhanced so that high corrosion resistance and erosion resistance can be acquired, and reliability can be improved, an impeller, a compressor, a metal part manufacturing method, an impeller manufacturing method, and a compressor manufacturing method.

Solution to Problem

50 **[0011]** According to a first aspect of the present invention, there is provided a coating structure including a chemical conversion layer that is made of a phosphate-coated film and is formed in a manner of covering a surface of a base material which is made of a magnesium alloy containing magnesium as a main component. The coating structure also includes a plating layer that is made of a nickel-based alloy and is formed in a manner of covering the chemical conversion layer.

55 **[0012]** According to the configuration, the plating layer made of the nickel-based alloy more favorably comes into tight contact with the chemical conversion layer made of the phosphate-coated film. Therefore, reliability can be improved. When there is provided such a plating layer, high corrosion resistance and erosion resistance can be acquired.

[0013] According to a second aspect of the present invention, in the coating structure, the plating layer of the coating

structure in the first aspect may be formed of a nickel-phosphorous alloy.

[0014] When there is provided the chemical conversion layer in this manner, adhesion between the magnesium alloy and the plating layer can be particularly and effectively enhanced.

[0015] According to a third aspect of the present invention, in the coating structure, the base material of the coating structure in the first or second aspect may contain a atom percent of zinc and may contains b atom percent of at least one kind of element, in total, selected from a group consisting of gadolinium, terbium, thulium, and lutetium. In this coating structure, a remaining portion may be made of magnesium, and the factors a and b may satisfy the following expressions (1) to (3). Moreover, in the coating structure, the base material may have at least one kind of precipitate selected from a precipitate group consisting of a compound of magnesium and a rare earth element, a compound of magnesium and zinc, a compound of zinc and a rare earth element, and a compound of magnesium, zinc, and a rare earth element.

$$(1) 0.2 \leq a \leq 5.0$$

$$(2) 0.5 \leq b \leq 5.0$$

$$(3) 0.5a - 0.5 \leq b$$

[0016] In the base material made of such an alloy, even though the base material is intended to be directly coated with the plating layer, the adhesion deteriorates. In this case, when the chemical conversion layer is interposed by means of chemical conversion treatment, adhesion between the base material and the plating layer can be effectively enhanced, so that reliability can be improved. Moreover, corrosion resistance can be improved by means of the chemical conversion treated layer. In addition, corrosion resistance and erosion resistance can also be improved by means of the plating layer.

[0017] According to a fourth aspect of the present invention, an impeller includes the coating structure according to any one of the first to third aspects.

[0018] Accordingly, corrosion resistance and erosion resistance of the magnesium alloy can be enhanced. Therefore, when the impeller is formed of the magnesium alloy and weighs light, an operation response of a compressor employing the impeller can be effectively enhanced.

[0019] According to a fifth aspect of the present invention, a compressor includes the impeller according to the fourth aspect.

[0020] Accordingly, in a case where the impeller is formed of a magnesium alloy, corrosion resistance and erosion resistance of the impeller can be enhanced. Therefore, the impeller weighs light, and an operation response of the compressor employing the impeller can be effectively enhanced.

[0021] According to a sixth aspect of the present invention, there is provided a metal part manufacturing method including a step of forming a chemical conversion layer by performing chemical conversion treatment in a manner of covering a surface of a base material which is made of a magnesium alloy containing magnesium as a main component. The metal part manufacturing method also includes a step of forming a plating layer which is made of a nickel-based alloy in a manner of covering the chemical conversion layer.

[0022] Accordingly, the plating layer made of the nickel-based alloy favorably comes into tight contact with the base material. Therefore, reliability can be improved. Moreover, when there is provided the plating layer, high corrosion resistance and erosion resistance can be acquired.

[0023] According to a seventh aspect of the present invention, an impeller manufacturing method includes the metal part manufacturing method according to the sixth aspect.

[0024] Accordingly, corrosion resistance and erosion resistance of the magnesium alloy can be enhanced. Therefore, when the impeller is formed of a magnesium alloy and weighs light, an operation response of the compressor employing the impeller can be effectively enhanced.

[0025] According to an eighth aspect of the present invention, a compressor manufacturing method includes the impeller manufacturing method according to the seventh aspect.

[0026] Accordingly, the impeller can weigh light, so that an operation response of the compressor employing the impeller can be effectively enhanced.

Advantageous Effects of Invention

[0027] According to the coating structure, the impeller, and the compressor described above, adhesion between the

base material made of the magnesium alloy and the plating layer made of the nickel-based alloy is enhanced so that high corrosion resistance and erosion resistance can be acquired and reliability can be improved. Brief Description of Drawings

[0028]

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Fig. 1 is a view illustrating a schematic configuration of a compressor according to an embodiment of the present invention.

Fig. 2 is a view illustrating a cross-sectional view of a coating structure according to the embodiment of the present invention.

10 Fig. 3 is a flow of an impeller manufacturing method according to the embodiment of the present invention.

Description of Embodiments

15 **[0029]** Fig. 1 is a view illustrating a schematic configuration of a compressor according to an embodiment of the present invention.

[0030] For example, the compressor of the embodiment is a centrifugal compressor which is provided in a turbocharger turbo-charging an internal combustion engine.

20 **[0031]** As illustrated in Fig. 1, for example, a compressor 1 employed in an engine compresses a fluid AR sent into a housing 2 when an impeller (metal part) 3 rotates inside the housing 2. Here, the shape of the impeller 3 or the configuration of the compressor 1 is not limited in any way.

[0032] The impeller 3 is disposed inside the housing 2 and compresses the fluid AR such as gas which becomes a compression subject. The impeller 3 is integrally provided with a rotary shaft 4 which is rotatably supported by a bearing 6 provided inside the housing 2. The rotary shaft 4 is rotatively driven around the central axis thereof by a turbine 5 which rotates due to exhaust gas G. Accordingly, the impeller 3 rotates together with the rotary shaft 4 and compresses the fluid AR flowing inside the housing 2.

[0033] The compressor 1 of the embodiment is embedded in a system which performs exhaust gas recirculation (EGR), and there are cases where air including exhaust gas which contains condensed moisture is taken in.

30 **[0034]** Fig. 2 is a view illustrating a cross-sectional view of a coating structure according to the embodiment of the present invention. Fig. 3 is a flow of an impeller manufacturing method according to the embodiment of the present invention.

[0035] As illustrated in Fig. 2, the impeller 3 includes an impeller body (base material) 10, a chemical conversion layer 11, and a plating layer 12. As illustrated in Fig. 3, in a method of manufacturing the impeller 3, first, a step of forming an impeller body 10 is performed (Step S01). Thereafter, a step of forming a chemical conversion layer 11 is performed (Step S02), and then a step of forming a plating layer 12 is performed (Step S03).

35 **[0036]** The impeller body 10 is made of a magnesium alloy. The magnesium alloy forming the impeller body 10 contains zinc (Zn) and at least one kind of element selected from a group consisting of gadolinium (Gd), terbium (Tb), thulium (Tm), and lutetium (Lu), and the remaining portion is made of magnesium (Mg).

[0037] Here, it is preferable that a content a (atom percent) of zinc (Zn) is set to $0.2 \leq a \leq 3.0$. Moreover, it is preferable that a content b (atom percent) of at least one kind of element selected from the group consisting of gadolinium (Gd), terbium (Tb), thulium (Tm), and lutetium (Lu) is set to $0.5 \leq b \leq 5.0$. Here, moreover, it is preferable that a relationship of $0.5a - 0.5 \leq b$ is satisfied.

in a case where gadolinium (Gd) is added, it is more preferable that the upper limit content is less than 3 atom percent. Moreover, it is particularly preferable that the ratio of the content of gadolinium (Gd) and the content zinc (Zn) is 2:1 or a ratio close thereto.

45 **[0038]** Due to such a content ratio, it is possible to particularly improve high strength high fracture toughness.

[0039] When the impeller body 10 is formed, a magnesium alloy made of the above-described composition is caused to melt and is cast into a mold, thereby forming a magnesium alloy cast.

50 **[0040]** In this magnesium alloy cast, at least one kind of precipitate selected from a precipitate group consisting of a compound of magnesium (Mg) and a rare earth element, a compound of magnesium (Mg) and zinc (Zn), a compound of zinc (Zn) and a rare earth element, and a compound of magnesium (Mg), zinc (Zn), and a rare earth element is precipitated.

[0041] Subsequently, the magnesium alloy cast is subjected to solution heat treatment. In the solution heat treatment, at least one kind of precipitate described above remains.

55 **[0042]** Thereafter, the magnesium alloy cast is subjected to machining, thereby acquiring the impeller body 10 having a predetermined shape.

[0043] For example, as the machining, it is possible to employ processing accompanying plastic deformation, such as extruding, an equal-channel-angular-extrusion (ECAE) processing method, rolling, drawing, forging, repetitive processing thereof, and friction stir welding (FSW).

[0044] The plastic processing can be performed alone or in combination of rolling, extruding, ECAE, drawing processing, and forging.

[0045] The chemical conversion layer 11 is formed in a manner of covering a surface of the impeller body 10. For example, the chemical conversion layer 11 is made of a phosphate-coated film. The phosphate-coated film is made of phosphate such as iron phosphate, manganese phosphate, and zinc phosphate. Such a phosphate-coated film is formed after the impeller body 10 is washed, and the impeller body 10 which becomes the base material is immersed in an aqueous solution containing phosphate for a predetermined time.

[0046] In a case where there is minute unevenness or the like on the surface of the base material 10, the chemical conversion layer 11 made of a phosphate-coated film may be formed to be thick such that the chemical conversion layer 11 can completely cover the unevenness. When the film thickness of the chemical conversion layer 11 made of such a phosphate-coated film is excessively thick, the weight thereof increases, thereby adversely affecting the response while the impeller 3 rotates.

[0047] Therefore, it is preferable that the chemical conversion layer 11 made of a phosphate-coated film has a film thickness ranging from 0.5 μm to 5 μm , and more preferably ranging from 2 μm to 5 μm .

[0048] Such a chemical conversion layer 11 may be formed by repeating the treatment of forming a phosphate-coated film multiple times and laminating multiple layers of phosphate-coated films.

[0049] The plating layer 12 is formed in a manner of covering the chemical conversion layer 11. The plating layer 12 is a plating film made of a nickel-based alloy which is formed by performing electroless plating treatment. As a specific example of the nickel-based alloy forming the plating layer 12, it is preferable to employ a nickel-phosphorous alloy.

[0050] The plating layer 12 made of the nickel-phosphorous alloy is formed to have a film thickness ranging from 10 μm to 30 μm , and more preferably ranging from 15 μm to 30 μm .

[0051] The plating layer 12 made of such a nickel-based alloy is formed by causing the impeller body 10 which is the base material having the chemical conversion layer 11 formed on the surface thereof to be immersed in a plating solution for a predetermined time and to be subjected to electroless plating.

[0052] The embodiment described above includes the chemical conversion layer 11 that is formed by performing chemical conversion treatment in a manner of covering a surface of the impeller body 10 which is made of a magnesium alloy, and the plating layer 12 that has a film thickness within a range set in advance and is formed in a manner of covering the chemical conversion layer 11. According to the configuration, the plating layer 12 more favorably comes into tight contact with the chemical conversion layer 11. When there is provided such a plating layer 12, it is possible to have high corrosion resistance.

[0053] In the compressor 1 including the impeller 3 having such a coating structure, and the impeller 3, the impeller 3 is formed of a magnesium alloy, so that it is possible to have high adhesion and corrosion resistance, and to enhance an operation response of the impeller 3 and the compressor 1.

[0054] Moreover, the chemical conversion layer 11 is a phosphate-coated film, and the plating layer 12 is formed of a nickel-phosphorous alloy.

[0055] Accordingly, adhesion between the magnesium alloy and the plating layer 12 can be particularly and effectively enhanced.

[0056] Moreover, the impeller body 10 contains zinc (Zn) and at least one kind of element selected from the group consisting of gadolinium (Gd), terbium (Tb), thulium (Tm), and lutetium (Lu), and the remaining portion is made of magnesium (Mg). Moreover, the impeller body 10 has at least one kind of precipitate selected from the precipitate group consisting of a compound of magnesium (Mg) and a rare earth element, a compound of magnesium (Mg) and zinc (Zn), a compound of zinc (Zn) and a rare earth element, and a compound of magnesium (Mg), zinc (Zn), and a rare earth element.

[0057] In the impeller body 10 made of such an alloy, even though the impeller body 10 is intended to be directly coated with the plating layer 12, the corrosion resistance deteriorates. In this case, when the chemical conversion layer 11 is interposed by means of the chemical conversion treatment, adhesion between the impeller body 10 and the plating layer 12 can be effectively enhanced.

Example

[0058] Next, in regard to the coating structure described above, the presence or absence of an occurrence of corrosion resistance and erosion was checked, and the result thereof will be shown.

[Base Material]

[0059] First, a magnesium alloy which contained 2 atom percent of Gd and 1 atom percent of Zn and of which the remaining portion thereof was made of Mg and unavoidable impurities was put into a vacuum melting furnace, and melting was performed.

[0060] Next, a heated and melted material was put into a mold and was cast, thereby producing a rectangular-shaped base material of 150 mm × 60 mm made of a magnesium alloy.

[Surface Treatment]

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[0061] After the produced base material was washed, the following surface treatment was executed.

(Example 1)

10 **[0062]** After producing a phosphate-coated film on a surface of the base material, plating was executed by means of a nickel-phosphorous alloy.

[0063] For the phosphate-coated film, the base material was immersed in a phosphate treatment solution for a pre-determined time, thereby obtaining a phosphate-coated film having a film thickness of 3 μm.

15 **[0064]** For the plating performed by means of the nickel-phosphorous alloy, plating treatment was executed by employing a plating bath. Accordingly, a plating layer having a film thickness of 15 μm was obtained.

(Comparative Example 1)

[0065] A base material was used as a test piece without executing surface treatment for the base material.

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(Comparative Example 2)

[0066] Only a phosphate-coated film was formed in a base material under the conditions similar to those of Example.

25

(Comparative Example 3)

[0067] Resin coating was executed for a base material.

[0068] A Si-based resin was employed for resin coating, and a resin coat layer was formed on a surface of the base material by performing painting.

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(Comparative Example 4)

[0069] After a phosphate-coated film was formed on a base material under the conditions similar to those of Example, resin coating was executed under the conditions similar to those of Comparative Example 3.

35

(Comparative Example 5)

[0070] Only plating treatment was executed for a base material by means of a nickel-phosphorous alloy under the conditions similar to those of Example.

40

(Comparative Example 6)

[0071] After resin coating was executed for a base material under the conditions similar to those of Comparative Example 3, plating treatment was executed by means of a nickel-phosphorous alloy under the conditions similar to those of Example.

45

[Adhesion of Film]

[0072] In regard to the test pieces of Example 1 and Comparative Examples 1 to 6, first, adhesion with respect to the base material which was a film formed by performing surface treatment was visually checked.

50

[0073] Table 1 shows the result thereof.

[Table 1]

55

	Coating	Film adhesion	Corrosion resistance	erosion
Example 1	Phosphate-coated film + Ni-P alloy plating	○	○	○

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(continued)

	Coating	Film adhesion	Corrosion resistance	erosion
5	Comparative Example 1	None	-	×
	Comparative Example 2	Phosphate-coated film	○	×
10	Comparative Example 3	Resin coating	○	×
	Comparative Example 4	Phosphate-coated film + resin coating	○	×
15	Comparative Example 5	Plating by means of Ni-P alloy	×	-
	Comparative Example 6	Resin coating + plating by means of Ni-P alloy	×	-

20 **[0074]** As a result, in Example 1 and Comparative Examples 2 to 5, a film was formed in each of the base materials by performing the surface treatment.

25 **[0075]** In contrast, in Comparative Example 6 in which the resin coating was executed for the base material and then the plating treatment was executed by means of the nickel-phosphorous alloy, peeling of the generated plating layer was checked when the plating treatment was performed with respect to the base material which was subjected to the resin coating.

[Corrosion Resistance]

30 **[0076]** Next, in Example 1 and Comparative Examples 1 to 5 in which the films were favorably formed, a salt spray test was performed based on a salt spray cycle test conforming to "H 8502" in Japanese Industrial Standard, thereby verifying the corrosion resistance.

35 **[0077]** In each of Example 1 and Comparative Examples 1 to 5, evaluation after the salt spray test was carried out by visually observing the circumstances of corrosion failure which occurred on the surface of the test piece, and measuring and checking a corrosion weight loss.

[0078] As a result, as shown in Table 1, in Example 1, an occurrence of corrosion was not particularly recognized.

40 **[0079]** In contrast, in Comparative Example 1 in which a bare base material was employed, corrosion was recognized in its entirety. Moreover, in Comparative Example 2 in which only a phosphate-coated film was provided, an amount of corrosion more than that in Comparative Example 1 was checked. Also in Comparative Example 3 in which only resin coating was employed, an amount of corrosion more than that in Comparative Example 1 was checked.

[0080] In Comparative Example 4 in which a phosphate-coated film and resin coating were provided, corrosion due to the salt spray test was not recognized.

45 **[0081]** In Comparative Example 5 in which only plating was executed by means of a NiP alloy, peeling of the plating film due to the salt spray test was checked.

[Erosion Resistance]

50 **[0082]** Next, in Example 1 and Comparative Examples 1 to 4 in which peeling of the film due to the salt spray test was not recognized, an erosion resistance test was performed by putting water droplets into an inlet of the compressor, and while the quantity of water droplets was controlled, the presence or absence of an occurrence of erosion was verified.

[0083] In each of Example 1 and Comparative Examples 1 to 4, the evaluation of the presence or absence of an occurrence of erosion was carried out by visually checking the surface of the test piece.

[0084] As a result, as shown in Table 1, no occurrence of erosion was recognized in Example 1.

[0085] In contrast, in each of Comparative Examples 1 to 4, an occurrence of erosion was recognized.

55 **[0086]** In this manner, in only Example 1 in which a phosphate-coated film and a plating layer by means of a Ni-P alloy were provided, it was checked that the adhesion, the corrosion resistance, and the erosion resistance of the film were high.

(Other Embodiments)

[0087] The present invention is not limited to the embodiment described above and the design can be changed within a scope not departing from the gist of the present invention.

5 **[0088]** For example, in the embodiment described above, the impeller 3 for the compressor 1 has been exemplified as a metal part having the coating structure. However, without being limited to the impeller, the configuration can be employed in various other metal members including a magnesium alloy as a base material.

[0089] Moreover, in the embodiment described above, the compressor of the turbocharger has been exemplified. However, the configuration can also be applied to an impeller of a compressor other than the turbocharger.

10 **[0090]** Moreover, in the embodiment described above, a case of laminating only one plating layer formed of a nickel-phosphorous alloy on the phosphate-coated film has been exemplified. However, multiple plating layers formed by means of the nickel-phosphorous alloy may be provided without being limited to one layer. For example, after a first plating layer made of a nickel-phosphorous alloy is laminated on the phosphate-coated film, a second plating layer made of a nickel-phosphorous alloy may be laminated in the same manner.

15 **[0091]** In a case where the first plating layer and the second plating layer are provided, compared to the case where one plating layer is formed of a nickel-phosphorous alloy, the film thickness of the first plating layer can be reduced. Therefore, adhesion of the first plating layer with respect to the phosphate-coated film can be improved.

20 **[0092]** Moreover, the composition of the nickel-phosphorous alloy forming the first plating layer and the second plating layer is not limited to the nickel-phosphorous alloy of the same composition. For example, a nickel-phosphorous alloy having adhesion with respect to a phosphate-coated film higher than that of the second plating layer may be employed for the first plating layer.

Industrial Applicability

25 **[0093]** When there is provided a chemical conversion layer which is formed by performing chemical conversion treatment in a manner of covering a surface of a base material made of a magnesium alloy and has a film thickness within a range set in advance, adhesion and corrosion resistance of a plating layer can be enhanced. Reference Signs List

[0094]

- 30 1 COMPRESSOR
 2 HOUSING
 3 IMPELLER
 4 ROTARY SHAFT
 5 TURBINE
 35 10 IMPELLER BODY
 11 CHEMICAL CONVERSION LAYER
 12 PLATING LAYER

40 **Claims**

1. A coating structure comprising:

45 a chemical conversion layer that is made of a phosphate-coated film and is formed in a manner of covering a surface of a base material which is made of a magnesium alloy containing magnesium as a main component; and a plating layer that is made of a nickel-based alloy and is formed in a manner of covering the chemical conversion layer.

2. The coating structure according to Claim 1,
 50 wherein the plating layer is formed of a nickel-phosphorous alloy.

3. The coating structure according to Claim 1 or 2,
 wherein the base material contains a atom percent of zinc, contains b atom percent of at least one kind of element, in total, selected from a group consisting of gadolinium, terbium, thulium, and lutetium, has a remaining portion made of magnesium, and has the factors a and b satisfying the following expressions (1) to (3), and
 55 wherein the base material has at least one kind of precipitate selected from a precipitate group consisting of a compound of magnesium and a rare earth element, a compound of magnesium and zinc, a compound of zinc and a rare earth element, and a compound of magnesium, zinc, and a rare earth element.

(1) $0.2 \leq a \leq 5.0$

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(2) $0.5 \leq b \leq 5.0$

(3) $0.5a - 0.5 \leq b$

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4. An impeller comprising:

the coating structure according to any one of Claims 1 to 3.

15

5. A compressor comprising:

the impeller according to Claim 4.

6. A metal part manufacturing method comprising:

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a step of forming a chemical conversion layer by performing chemical conversion treatment in a manner of covering a surface of a base material which is made of a magnesium alloy containing magnesium as a main component; and

a step of forming a plating layer which is made of a nickel-based alloy in a manner of covering the chemical conversion layer.

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7. An impeller manufacturing method comprising:

the metal part manufacturing method according to Claim 6.

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8. A compressor manufacturing method comprising:

the impeller manufacturing method according to Claim 7.

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Amended claims under Art. 19.1 PCT

1. Amended] A coating structure comprising:

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a chemical conversion layer that contains magnesium as a main component and is made of a phosphate-coated film and is formed in a manner of covering a surface of a base material which is made of a magnesium alloy containing at least one kind of element selected from a group consisting of gadolinium, terbium, thulium, and lutetium; and

a plating layer that is made of a nickel-based alloy and is formed in a manner of covering the chemical conversion layer.

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2. The coating structure according to Claim 1, wherein the plating layer is formed of a nickel-phosphorous alloy.

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3. The coating structure according to Claim 1 or 2, wherein the base material contains a atom percent of zinc, contains b atom percent of at least one kind of element, in total, selected from a group consisting of gadolinium, terbium, thulium, and lutetium, has a remaining portion made of magnesium, and has the factors a and b satisfying the following expressions (1) to (3), and wherein the base material has at least one kind of precipitate selected from a precipitate group consisting of a compound of magnesium and a rare earth element, a compound of magnesium and zinc, a compound of zinc and a rare earth element, and a compound of magnesium, zinc, and a rare earth element.

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(1) $0.2 \leq a \leq 5.0$

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(2) $0.5 \leq b \leq 5.0$

(3) $0.5a - 0.5 \leq b$

10

4. An impeller comprising:

the coating structure according to any one of Claims 1 to 3.

15

5. A compressor comprising:

the impeller according to Claim 4.

20

6. A metal part manufacturing method comprising:

a step of forming a chemical conversion layer by performing chemical conversion treatment in a manner of covering a surface of a base material which is made of a magnesium alloy containing magnesium as a main component; and
a step of forming a plating layer which is made of a nickel-based alloy in a manner of covering the chemical conversion layer.

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7. An impeller manufacturing method comprising:

the metal part manufacturing method according to Claim 6.

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8. A compressor manufacturing method comprising:

the impeller manufacturing method according to Claim 7.

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FIG. 1

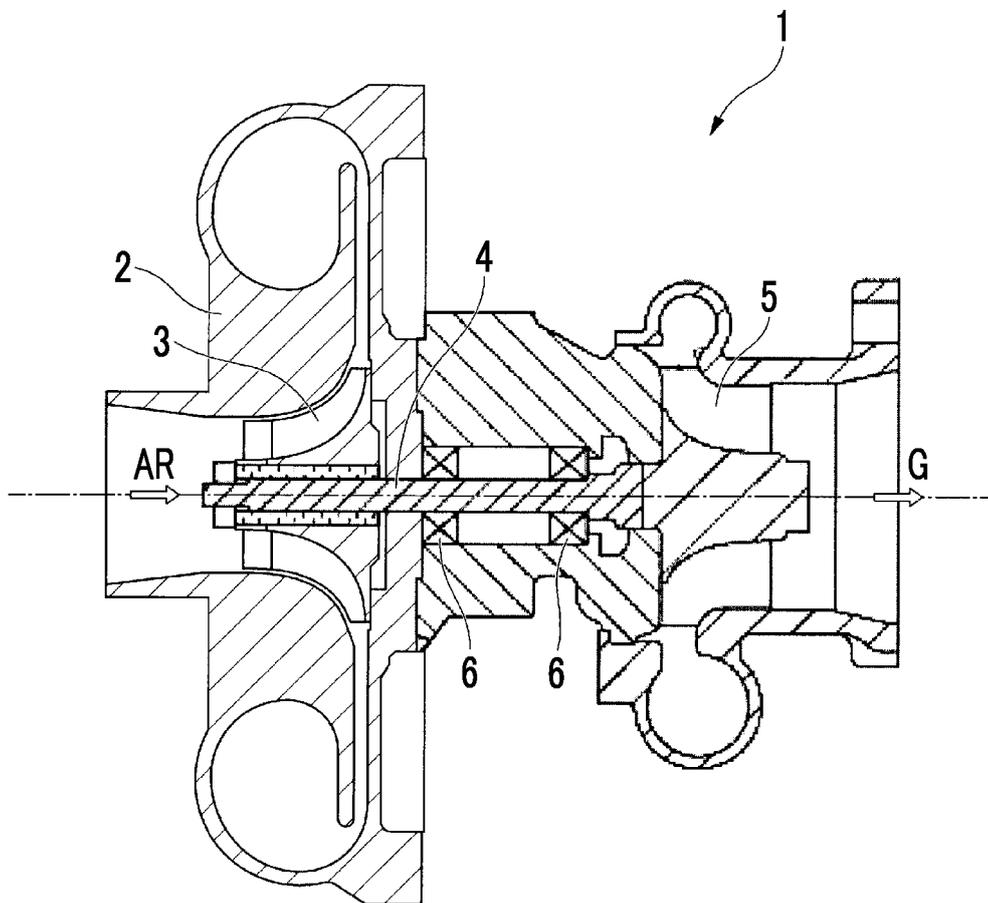


FIG. 2

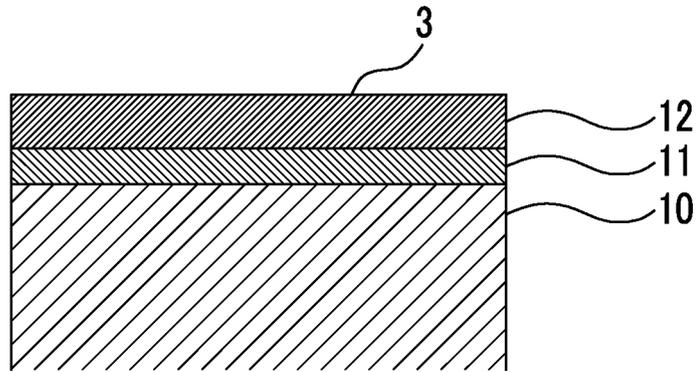
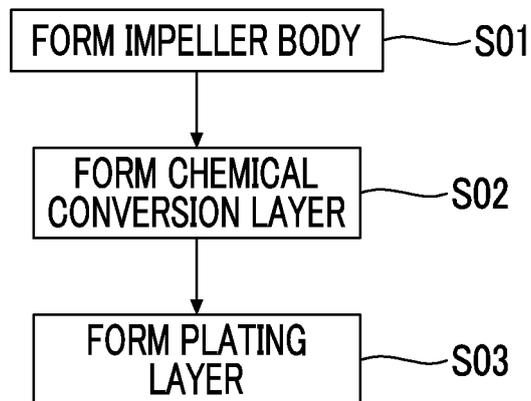


FIG. 3



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2015/077940

5	A. CLASSIFICATION OF SUBJECT MATTER C23C28/00(2006.01) i, C23C18/32(2006.01) i, C23C22/07(2006.01) i	
	According to International Patent Classification (IPC) or to both national classification and IPC	
10	B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) C23C28/00, C23C18/32, C23C22/07	
15	Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2015 Kokai Jitsuyo Shinan Koho 1971-2015 Toroku Jitsuyo Shinan Koho 1994-2015	
	Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)	
20	C. DOCUMENTS CONSIDERED TO BE RELEVANT	
	Category*	Citation of document, with indication, where appropriate, of the relevant passages
25	X A	JP 5-271996 A (Nihon Parkerizing Co., Ltd.), 19 October 1993 (19.10.1993), claims 1 to 2; paragraphs [0010] to [0043] (Family: none)
30	X A	JP 10-287986 A (Kobe Steel, Ltd.), 27 October 1998 (27.10.1998), claims 1 to 7; paragraphs [0037] to [0056] & US 6068938 A claims 1 to 15; column 8, line 7 to column 14, line 18
35	X A	JP 2006-233245 A (OM Sangyo Co., Ltd.), 07 September 2006 (07.09.2006), claims 1 to 6; paragraphs [0016] to [0081] (Family: none)
40	<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/> See patent family annex.	
45	* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family
50	Date of the actual completion of the international search 22 October 2015 (22.10.15)	Date of mailing of the international search report 02 November 2015 (02.11.15)
55	Name and mailing address of the ISA/ Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT

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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2011-12293 A (Daiwa Fine Chemicals Co., Ltd.), 20 January 2011 (20.01.2011), claims 1 to 9; paragraphs [0033] to [0035] (Family: none)	1-8
A	JP 2007-178234 A (Seiko Clock Inc.), 12 July 2007 (12.07.2007), claim 1; paragraphs [0065] to [0069] (Family: none)	1-8

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2003073843 A [0008]