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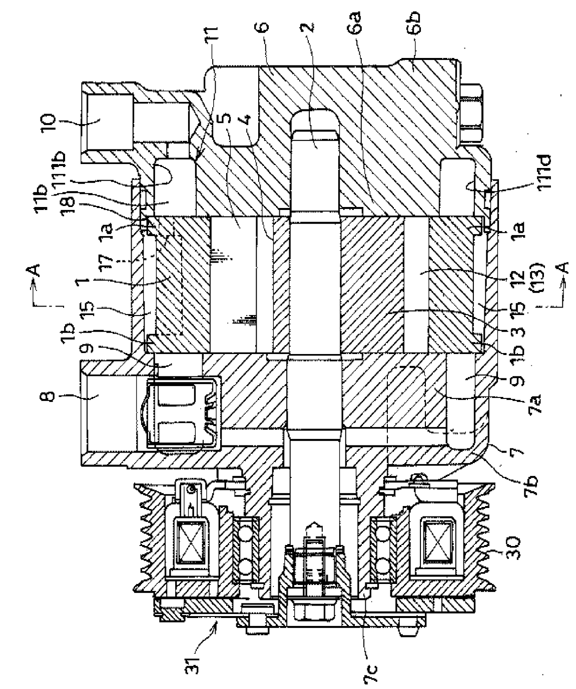
(54) **SLIDING MEMBER FOR COMPRESSOR**

(57) A sliding member for a compressor according to the present disclosure is a sliding member for a compressor including a base material formed of an aluminum alloy, and an electroless nickel plating layer containing phosphorus which is formed on a surface of the base material, in which in the electroless nickel plating layer, a phosphorus (P) content is 1.0 mass% to 2.0 mass%, a boron (B) content is 0 mass% to 0.01 mass%, and a cobalt (Co) content is 0 mass% to 0.01 mass%, and in which the electroless nickel plating layer is a non-heat treated layer, the electroless nickel plating layer contains Ni crystallites, and a crystallite diameter of the crystallites measured by an X-ray diffraction method is 8 nm to 11 nm.

[FIG. 4]



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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present disclosure relates to a sliding member of a compressor such as a vane compressor of an air conditioner for a motor vehicle, and applies low-phosphorus nickel plating to the sliding member for the purpose of reducing the cost of the sliding member such as a vane.

2. Description of the Related Art

[0002] A vane compressor, for example, includes a cam ring, a rotor which is rotatably accommodated in the cam ring and is fixed to a drive shaft, vanes which are inserted into a plurality of vane grooves provided at the rotor, a front side member which is fixed to one end surface of the cam ring, and a rear side member which is fixed to the other end surface of the cam ring. The drive shaft is rotatably supported by the front side member and the rear side member via bearings. For example, a suction port for a working fluid (refrigerant gas) and a suction chamber (a low-pressure chamber) communicating with the suction port are formed in the front side member, and a discharge port for the working fluid and a discharge chamber

[0003] (a high-pressure chamber) communicating with the discharge port are formed in the rear side member (refer to Figs. 1 to 8 in Patent Literature 1.).

[0004] Since a slide between aluminum members are to be avoided, and since hardness for abrasion resistance and toughness against impact are required, hard nickel-phosphorus plating is generally applied to aluminum vanes of the vane compressor (for example, refer to Patent Literatures 2 to 4.).

Patent Literature 1: WO2008/026496
Patent Literature 2: JP-A-8-158058
Patent Literature 3: JP-A-2003-161259
Patent Literature 4: JP-A-2003-184743

SUMMARY OF THE INVENTION

[0005] The hardness of Ni-P plating increases when applying heat treatment, but the toughness of the plating decreases. Therefore, in order to satisfy both the hardness and toughness, for example, Ni-P-B plating blended with boron is used as described in a technique of Patent Literature 2 or Patent Literature 3, or for example, Ni-Co-P plating blended with cobalt is used as described in a technique of Patent Literature 4. However, these plating is expensive.

[0006] In addition, Ni particles might adhere to a surface of a plated vane and a post-process for removing the Ni particles is required, which increases the cost.

[0007] Therefore, an object of the present disclosure is to provide a sliding member for a compressor whose sliding portion is applied with a plating film, in which both the hardness and toughness of the plating film are good, adhesion of the Ni particles is inhibited, and the plating film is inexpensive.

[0008] The present inventors found that an electroless low-phosphorus nickel plating layer which is a non-heat treated layer and contains Ni crystallites having a crystallite diameter of 8 nm to 11 nm provides both good hardness and toughness of a plating film and solved the problem of the present invention. That is, a sliding member for a compressor according to the present invention is a sliding member for a compressor including a base material formed of an aluminum alloy, and an electroless nickel plating layer containing phosphorus which is formed on a surface of the base material, in which in the electroless nickel plating layer, a phosphorus (P) content is equal to or more than 1.0 mass% and equal to or less than 2.0 mass%, a boron (B) content is equal to or more than 0 mass% and equal to or less than 0.01 mass%, and a cobalt (Co) content is equal to or more than 0 mass% and equal to or less than 0.01 mass%, the electroless nickel plating layer is a non-heat treated layer, the electroless nickel plating layer contains Ni crystallites, and a crystallite diameter of the Ni crystallites measured by an X-ray diffraction method is 8 nm to 11 nm.

[0009] In the sliding member for a compressor according to the present invention, a Vickers hardness of the electroless nickel plating layer is preferably equal to or more than 650 Hv and equal to or less than 750 Hv.

[0010] In the sliding member for a compressor according to the present invention, the electroless nickel plating layer preferably does not contain boron (B) and cobalt (Co). According to the present configuration, a plating solution to be used can be made inexpensive.

[0011] In the sliding member for a compressor according to the present invention, the electroless nickel plating layer is preferably a barrel plating layer. According to the present configuration, Ni particles are prevented from accumulating, and smoothness of the member increases.

[0012] It is preferable that the sliding member for a compressor according to the present invention has an underlayer between the base material and the electroless nickel plating layer, and the underlayer is an electroless nickel plating layer containing 6.0 mass% to 11.0 mass% of phosphorus (P) and a non-heat treated layer. According to the present configuration, since the underlayer is a medium phosphorus type plating layer, adhesion with the base material is good, and smoothness increases.

[0013] In the sliding member for a compressor according to the present invention, the underlayer preferably does not contain boron (B) and cobalt (Co). According to the present configuration, a plating solution to be used can be made inexpensive.

[0014] In the sliding member for a compressor according to the present invention, a film thickness of the electroless nickel plating layer formed on the surface of the base material or a total thickness of the underlayer formed on the surface of the base material and the electroless nickel plating layer is preferably 15 μm to 30 pm. According to the present configuration, the film thickness of the plating film is optimal to a vane to be used.

[0015] In the sliding member for a compressor according to the present invention, the electroless nickel plating layer is preferably a non-dispersion plating film where ceramic particulates do not disperse in the layer. The hardness and scratch strength of the plating film can be improved.

[0016] According to the present disclosure, the sliding member for a compressor whose sliding portion is applied with the plating film can be provided, in which both the hardness and toughness of the plating film are satisfied, adhesion of Ni particles is inhibited, and the plating film is inexpensive.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017]

Fig. 1 illustrates a relationship between a phosphorus content and a nickel crystallite diameter of an electroless nickel plating layer in Examples.

Fig. 2 illustrates a relationship between the nickel crystallite diameter and hardness of the electroless nickel plating layer in Examples.

Fig. 3 illustrates a relationship between the nickel crystallite diameter and scratch strength of the electroless nickel plating layer in Examples.

Fig. 4 is a sectional view illustrating a configuration example of a vane compressor which includes vanes configuring sliding members according to the present embodiment.

Fig. 5 is a sectional view taken along a line A-A in Fig. 4.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0018] Hereinafter, an aspect of the present invention will be described with reference to the attached drawings. Embodiments to be described hereinafter are Examples of the present invention, and the present invention is not limited to the embodiments hereinafter. It should be noted that in the present specification and drawings, constituent elements with the same reference numerals mutually indicate the same element. Various modifications may be made as long as the effect of the present invention is achieved.

[0019] First, a sliding member for a compressor will be described. Compressors include a vane compressor, a swash plate compressor and the like. Fig. 4 and Fig. 5 illustrate a configuration of the vane compressor as an example. The vane compressor includes a cam ring 1, a rotor 3 which is rotatably accommodated in the cam ring and is fixed to a drive shaft 2, vanes 5 which are inserted into a plurality of vane grooves 4 provided at the rotor 3, a rear side member 6 which is fixed to a rear side end surface of the cam ring 1, and a shell member 7 which surrounds a front side end surface and an outer circumferential surface of the cam ring 1 and is fitted to the rear side member 6. The drive shaft 2 is rotatably supported by the shell member 7 and the rear side member 6 via bearings. A suction port 8 for a working fluid (refrigerant gas) and a suction chamber (a low-pressure chamber) 9 communicating with the suction port 8 are formed in the shell member 7, and a discharge port 10 for the working fluid and a discharge chamber (a high-pressure chamber) 11 communicating with the discharge port 10 are formed in the rear side member 6. A compression space 12 is defined between an inner circumferential surface of the cam ring 1 and an outer circumferential surface of the rotor 3. The compression space 12 is divided by the vanes 5 to form a plurality of compression chambers 13, and a capacity of each compression chamber varies according to rotation of the rotor 3.

[0020] In the vane compressor, during the rotation of the rotor 3, sliding occurs between a tip surface of the vane 5 and the inner circumferential surface of the cam ring 1, between two side surfaces of the vane 5 and inner side surfaces of the rear side member 6 and the shell member 7, and between both front and back side surfaces of the vane 5 and an inside surface of the vane groove 4. Therefore, besides the vane 5 is required to have high hardness and abrasion resistance, the vane 5 is strongly required that a plating layer formed on the surfaces of the vane 5 is not peeled off, even in a case where foreign matters enter between the rotor 3, the cam ring 1 or the rear side member 6, and the shell member 7 and a scrape is generated on the surfaces of the vane 5. In a case where a base material of the vane 5 is formed from a material containing aluminum as a main component for the purpose of weight reduction or the like, if a plating film is formed on surfaces of the base material of the vane 5, the requirements of the above-mentioned hardness and peel resistance can be satisfied well. In addition, the cam ring 1, the rear side member 6, the shell member 7, the rotor 3 and the like of the vane compressor can also be considered as sliding members, and the plating film may be formed on the surfaces thereof, so that the requirements of the hardness and abrasion resistance can also be satisfied.

[0021] Similarly, in a case of the swash plate compressor, a plating film is formed in a portion where members are in slide contact with each other, so that the requirements of the hardness and abrasion resistance can also be satisfied.

[0022] A material of the sliding member is, for example, an aluminum-based alloy. Examples of the aluminum-based alloy include an aluminum-based alloy such as 2000 series, 4000 series, 5000 series, 6000 series and 7000 series, and an aluminum alloy having a high silicon content such as ADC10, ADC12, ADC14 and A390. In the present embodiment, the material of the sliding member is preferably an aluminum-based alloy.

[0023] Next, the sliding member for a compressor where the plating film (also called plating layer) is formed will be described. In the sliding member for a compressor according to the present embodiment, an electroless nickel plating layer is formed on at least a sliding portion. That is, the sliding member for a compressor according to the present embodiment is a sliding member for a compressor including a base material formed of an aluminum alloy, and an electroless nickel plating layer containing phosphorus which is formed on a surface of the base material, in which in the electroless nickel plating layer, a phosphorus (P) content is equal to or more than 1.0 mass% and equal to or less than 2.0 mass%, a boron (B) content is equal to or more than 0 mass% and equal to or less than 0.01 mass%, and a cobalt (Co) content is equal to or more than 0 mass% and equal to or less than 0.01 mass%, the electroless nickel plating layer is a non-heat treated layer and contains Ni crystallites, and a crystallite diameter of the crystallites measured by an X-ray diffraction method is 8 nm to 11 nm.

[0024] In the present embodiment, the plating film is deposited and formed by using an electroless plating bath which contains a nickel salt such as nickel sulfate and nickel chloride as a supply source of nickel ions, and a phosphorus compound such as sodium hypophosphite as a reducing agent. A ratio of the nickel salt to the phosphorus compound in the plating bath is appropriately adjusted in accordance with a composition of the plating film. A stabilizer for preventing decomposition of a plating solution and inhibiting plating deposition, a pH adjuster such as sodium hydroxide and aqueous ammonia, a complexing agent containing an organic acid such as sodium acetate and sodium citrate, and a buffer such as sodium citrate can be added into the plating bath. The plating film can be formed by immersing a surface to be plated of the base material in the plating bath for constant time. A temperature of the plating bath is determined in consideration of stability and deposition speed of the bath, but is suitable to be set in a range of, for example, 60°C to 95°C, preferably 70°C to 90°C. In addition, a film thickness of the plating film can be appropriately adjusted by adjusting immersion time in the plating bath.

[0025] The phosphorus (P) content in the electroless nickel plating layer is equal to or more than 1.0 mass% and equal to or less than 2.0 mass%. In general, a nickel plating film having a phosphorus content of 8 mass% to 10 mass% belongs to a "medium phosphorus" type. In addition, a nickel plating film having a phosphorus content of 10 mass% to 11 mass% belongs to a "medium-high phosphorus" type. A nickel plating film which contains these types and has a phosphorus content of 8 mass% to 11 mass% is excellent in ease of using the plating bath, deposition speed of the plating film, and film dispersion, so that a versatility thereof is high. In the present embodiment, the nickel plating film has a phosphorus (P) content being equal to or more than 1.0 mass% and equal to or less than 2.0 mass%, and belongs to a "low phosphorus" type plating film rather than the "medium phosphorus" type and the "medium-high phosphorus" type. When the phosphorus (P) content is less than 1.0 mass%, the electroless nickel plating layer cannot be formed, or a film formation speed slows down. When the phosphorus (P) content exceeds 2.0 mass%, the desired Ni crystallites cannot be obtained. The plating solution for forming the "low phosphorus" type nickel plating layer is difficult to generate Ni particles in terms of the characteristics, and a post-process for removing the Ni particles can be omitted.

[0026] The boron (B) content in the electroless nickel plating layer is equal to or more than 0 mass% and equal to or less than 0.01 mass%, and the electroless nickel plating layer preferably does not contain boron (B). The plating solution is preferably not substantially blended with a boron component. The plating solution can be made inexpensive because boron is not blended.

[0027] The cobalt (Co) content in the electroless nickel plating layer is equal to or more than 0 mass% and equal to or less than 0.01 mass%, and the electroless nickel plating layer preferably does not contain cobalt (Co). The plating solution is preferably not substantially blended with a cobalt component. The plating solution can be made inexpensive because the cobalt component is not blended.

[0028] The electroless nickel plating layer is a non-heat treated layer. Since the electroless nickel plating layer is the non-heat treated layer, toughness of the plating layer can be increased and hardness of the base material does not decrease.

[0029] The electroless nickel plating layer contains the Ni crystallites, and the crystallite diameter of the crystallites, which are measured by the X-ray diffraction method, is 8 nm to 11 nm. A crystallite size is set in this range, so that sufficient hardness is obtained as necessary without a heat treatment. That is, Vickers hardness of the electroless nickel plating layer is 650 Hv to 750 Hv. An upper limit of the Vickers hardness of the electroless nickel plating layer may be 700 Hv. When the crystallite diameter of the crystallites is less than 8 nm, the plating film does not have high hardness, for example, the Vickers hardness is lower than 650 Hv. In a case where the crystallite diameter of the crystallites exceeds 11 nm, the film formation speed slows down, and the film is difficult to be formed.

[0030] The electroless nickel plating layer is preferably a non-dispersion plating film where ceramic particulates do not disperse in the layer. A dispersion plating film where ceramic particulates disperse in the layer provides high hardness. However, since scratch strength of the dispersion plating film tends to be small, it is preferable to satisfy the hardness and the scratch strength without using an effect of a composite in the present embodiment. In addition, since the plating layer does not contain the ceramic particulates, there is no attack to a counterpart member at the time of sliding.

[0031] The electroless nickel plating layer is preferably a barrel plating layer. By combining with a plating method in a barrel form, the Ni particles are prevented from accumulating and smoothness of the member increases.

[0032] It is preferable that the sliding member for a compressor according to the present embodiment includes an underlayer between the base material and the electroless nickel plating layer, and the underlayer is an electroless nickel plating layer containing 6.0 mass% to 11.0 mass% of phosphorus (P), and is a non-heat treated layer. The electroless nickel plating layer of medium to medium-high phosphorus types is provided as the underlayer, so that adhesion with the base material can be improved, and smoothness of the plating film can be increased. Further, the underlayer is provided, so that generation of Ni particles can be inhibited, and a removal process of the Ni particles can be omitted. Phosphorus (P) in the underlayer is preferably 6.5 mass% to 10.5 mass%, and more preferably 7.0 mass% to 10.0 mass%. When the phosphorus (P) in the underlayer is in a range of 6.0 mass% to 11.0 mass%, an electroless nickel plating acquires the most stable film formation reactivity and smoothness. On the contrary, when the phosphorus (P) in the underlayer is less than 6.0 mass%, or exceeds 11.0 mass%, a decrease in reactivity or abnormal particle growth due to an increase in side reaction or the like easily occurs, which causes a problem such as a decrease in smoothness. The underlayer is a non-heat treated layer. Since the underlayer is the non-heat treated layer, the toughness of the plating layer can be increased and the hardness of the base material does not decrease.

[0033] The underlayer preferably does not contain boron (B) and cobalt (Co). Similarly to the electroless nickel plating layer, a plating solution for the underlayer can be made inexpensive.

[0034] In the sliding member for a compressor according to the present embodiment, a film thickness of the electroless nickel plating layer formed on the surface of the base material is preferably 15 pm to 30 pm, and more preferably 18 pm to 25 pm. The film thickness is set to 15 μm to 30 pm, so that the substantial hardness for the abrasion resistance and the toughness against impact can be satisfied. When the film thickness is less than 15 pm, neither the hardness nor the toughness may be satisfied, and when the film thickness exceeds 30 pm, the film may be easily peeled off and productivity may decrease.

[0035] In the sliding member for a compressor according to the present embodiment, a total film thickness of the underlayer formed on the surface of the base material and the electroless nickel plating layer is preferably 15 pm to 30 pm, and more preferably 18 μm to 25 pm. The total film thickness is set to 15 μm to 30 pm, so that the hardness for the abrasion resistance and the toughness against impact can be satisfied. When the total film thickness is less than 15 pm, neither the hardness nor the toughness may be satisfied, and when the total film thickness exceeds 30 pm, the film may be easily peeled off, and the productivity and economy may decrease. In addition, the underlayer formed on the surface of the base material is preferably 1 μm to 15 pm, and more preferably 3 pm to 10 pm. The electroless nickel plating layer formed on the underlayer is preferably 15 μm to 25 pm.

Examples

[0036] The present invention will be described more specifically by listing Examples, but the present invention is not limited to the Examples.

[0037] Samples shown in Samples 1 to 9 were manufactured. The vane made of a high silicon-based aluminum alloy (Al-10.5 mass% to 20 mass% of Si) was immersed in a plating bath shown in Table 1 so as to form the electroless nickel plating layer, and then washed with water. The immersion time was adjusted such that the film thickness is the film thickness shown in Table 1. In a case where the plating film including the underlayer is formed, the vane was first immersed in a plating bath for a underlayer to form the underlayer, and then washed with water. Further, the vane was immersed in a plating bath for an electroless nickel plating layer to form the electroless nickel plating layer on the underlayer, and then washed with water.

[0038] Results of Samples 1 to 9 are shown in Table 1.

Table 1

Sample No.	Example/ comparative example	Aluminum alloy base material	Presence/ absence of underlayer	Plating bath for electroless nickel plating layer	Plating bath for underlayer	Phosphorus content in electroless nickel plating layer (mass%)	Nickel content in electroless nickel plating layer (mass%) *containing unavoidable impurities	Phosphorus content in underlayer (mass%)	Nickel content in underlayer (mass%) *containing unavoidable impurities
1	Comparative example	Al-10.5Si-4.8 Cu-0.6Mg	Absence	Plating bath for low phosphorus film manufactured by Company A	-	2.56	Remaining part	-	-
2	Comparative example	Al-10.5Si-4.8 Cu-0.6Mg	Absence	Plating bath For low-medium phosphorus film manufactured by Company B	-	6.72	Remaining part	-	-
3	Example	Al-20Si-5Fe-3.5Cu-1.2Mg	Absence	Plating bath for low phosphorus film manufactured by Uyemura & Co., Ltd. (Nimuden KHN)	-	1.22	Remaining part	-	-

Sample No.	Example/ comparative example	Aluminum alloy base material	Presence/ absence of underlayer	Plating bath for electroless nickel plating layer	Plating bath for underlayer	Phosphorus content in electroless nickel plating layer (mass%)	Nickel content in electroless nickel plating layer (mass%) *containing unavoidable impurities	Phosphorus content in underlayer (mass%)	Nickel content in underlayer (mass%) *containing unavoidable impurities
4	Example	Al-17Si-5Fe-3.5Cu-1 Mg	Presence	Plating bath for low phosphorus film manufactured by Uyemura & Co., Ltd. (Nimuden KHN)	-	1.66	Remaining part	-	-
					Plating Bath For Medium-High Phosphorus Film Manufactured by Uyemura & Co., Ltd. (Nimuden KTY)	-	-	8.30	remaining part
5	Example	Al-17Si-5Fe-3.5Cu-1 Mg	Absence	Plating bath for low phosphorus film manufactured by Uyemura & Co., Ltd. (Nimuden KHN)	-	1.63	Remaining part	-	-

Sample No.	Example/ comparative example	Aluminum alloy base material	Presence/ absence of underlayer	Plating bath for electroless nickel plating layer	Plating bath for underlayer	Phosphorus content in electroless nickel plating layer (mass%)	Nickel content in electroless nickel plating layer (mass%) *containing unavoidable impurities	Phosphorus content in underlayer (mass%)	Nickel content in underlayer (mass%) *containing unavoidable impurities
6	Example	Al-20Si-7.5Ni -2.5Cu-1 Mg	Presence	Plating bath for low phosphorus film manufactured by Uyemura & Co., Ltd. (Nimuden KHN)	-	1.08	Remaining part	-	-
					Plating bath for medium-high phosphorus film manufactured by Uyemura & Co., Ltd. (Nimuden KTY)	-	-	8.39	Remaining Part
7	Comparative example	Al-10.5Si-4.8 Cu-0.6Mg	Absence	Plating bath for low phosphorus composite plating film manufactured by Company C	-	4.45	Remaining part	-	-
8	Example	Al-10.5Si-4.8 Cu-0.6Mg	Absence	Plating bath for low phosphorus film manufactured by Coventya Inc.	-	1.89	Remaining Part	-	-

Sample No.	Example/ comparative example	Aluminum alloy base material	Presence/ absence of underlayer	Plating bath for electroless nickel plating layer	Plating bath for underlayer	Phosphorus content in electroless nickel plating layer (mass%)	Nickel content in electroless nickel plating layer (mass%) *containing unavoidable impurities	Phosphorus content in underlayer (mass%)	Nickel content in underlayer (mass%) *containing unavoidable impurities
9	Example	Al-20Si-5Fe-3.5Cu-1.2Mg	Absence	Plating bath for low phosphorus film manufactured By Coventya Inc.	-	1.60	Remaining Part	-	-
*Processing condition is according to the standard condition of each company									

Sample No.	Example/ comparative example	Ni crystallite diameter of electro less nickel plating layer (nm)	Film thickness (μm)	Total film thickness (μm)	Hardness (HV)	Scratch strength (N)	Remarks
1	Comparative example	6.9	24.9	24.9	647	26.6	-
2	Comparative example	3.0	17.8	17.8	621	12.0	-
3	Example	10.0	23.2	23.2	654	98 or greater	-
4	Example	9.4	23.0 3.0	26.0	656	98 or greater	-
5	Example	9.2	24.0	24.0	658	98 or greater	-
6	Example	10.8	16.8 3.2	20.0	652	98 or greater	-
7	Comparative example	5.1	20.4	20.4	692	18.0	Blending ceramic particles to plating film
8	Example	8.3	21.0	21.0	668	98 or greater	-
9	Example	8.5	27.7	27.7	662	98 or greater	-
*Processing condition is according to the standard condition of each company							

[Layer Composition]

[0039] Compositions of the electroless nickel plating layer and the underlayer were determined by an X-ray fluorescent analysis method.

[Crystallite Diameter]

[0040] The nickel crystallite diameter in the electroless nickel plating layer was determined by the X-ray diffraction method.

[Film Thickness]

[0041] The film thickness was determined by measurement according to an enlarged observation from a cut surface using an optical microscope.

[Hardness]

[0042] The hardness of the electroless nickel plating layer or the hardness of the electroless nickel plating layer including the underlayer was determined by a micro Vickers hardness meter (JIS Z 2244-2009).

[Scratch Strength]

[0043] A scratch test was carried out on the electroless nickel plating layer or the electroless nickel plating layer including the underlayer. A load variation type friction abrasion system HHS3000 manufactured by SHINTO Scientific Co., ltd. was used in the scratch test, an indenter which includes a conical tip end portion made of diamond and having an apex angle of 120° and a curvature radius of a tip end of 0.2 mm was used as a measurement indenter, and a load at a position where a crack was firstly confirmed in scratch traces formed by sweeping the plating film surface in a length range of 10 mm in a vertical direction while proportionally and gradually increasing from 0 N to 98 N was determined from a sweeping distance as the scratch strength.

[0044] Fig. 1 illustrates a relationship between a phosphorus content and a nickel crystallite diameter of an electroless nickel plating layer of Examples.

[0045] Fig. 2 illustrates a relationship between the nickel crystallite diameter and hardness of the electroless nickel plating layer of Examples.

[0046] Fig. 3 illustrates a relationship between the nickel crystallite diameter and scratch strength of the electroless nickel plating layer of Examples.

[0047] As illustrated in Fig. 1, the nickel crystallite diameter of the samples of Examples was in a range of 8 nm to 11 nm. As illustrated in Fig. 2, all Examples whose nickel crystallite diameter was in a range of 8 nm to 11 nm had 650 Hv or more in Vickers hardness. In Fig. 2, a Comparative Example (sample No.7) whose nickel crystallite diameter was 5.1 nm had 692 Hv in Vickers hardness, and the reason why high hardness was obtained is due to the combined effect of dispersing the ceramic particles in the electroless nickel plating layer. In Comparative Examples other than sample No.7, the ceramic particles were not dispersed, and Vickers hardness was less than 650 Hv. As illustrated in Fig. 3, all Examples whose nickel crystallite diameter was in a range of 8 nm to 11 nm had 98 N or more in scratch strength. In Fig. 3, Comparative Example (sample No.7) whose nickel crystallite diameter was 5.1 nm had the scratch strength as small as 18.0 N. In Comparative Example of sample No.7, as illustrated in Fig. 2, the Vickers hardness was high, but the scratch strength was small, and the high Vickers hardness and the large scratch strength could not be compatible.

[0048] In the Examples, adhesion of Ni particles is inhibited.

Description of Reference Numerals and Signs

[0049]

1	cam ring
1a	flange portion
2	drive shaft
3	rotor
4	vane groove
5	vane
6	rear side member
7	shell member
6a, 7a	side block portion
6b, 7b	head portion
8	suction port
9	low-pressure chamber
10	discharge port
11	high-pressure chamber
11a	first high-pressure chamber
11b	second high-pressure chamber
12	compression space
13	compression chamber
15	discharge valve accommodation chamber
17	through hole

Claims

1. A sliding member for a compressor comprising:

a base material formed of an aluminum alloy; and
an electroless nickel plating layer containing phosphorus which is formed on a surface of the base material,
wherein in the electroless nickel plating layer, a phosphorus (P) content is equal to or more than 1.0 mass% and equal to or less than 2.0 mass%, a boron (B) content is equal to or more than 0 mass% and equal to or

less than 0.01 mass%, and a cobalt (Co) content is equal to or more than 0 mass% and equal to or less than 0.01 mass%,
wherein the electroless nickel plating layer is a non-heat treated layer, and
wherein the electroless nickel plating layer contains Ni crystallites, and a crystallite diameter of the crystallites measured by an X-ray diffraction method is 8 nm to 11 nm.

2. The sliding member for a compressor according to claim 1, wherein a Vickers hardness of the electroless nickel plating layer is equal to or more than 650 Hv and equal to or less than 750 Hv.

3. The sliding member for a compressor according to claim 1 or 2, wherein the electroless nickel plating layer does not contain boron (B) and cobalt (Co).

4. The sliding member for a compressor according to any one of claims 1 to 3, wherein the electroless nickel plating layer is a barrel plating layer.

5. The sliding member for a compressor according to any one of claims 1 to 4 further comprising:

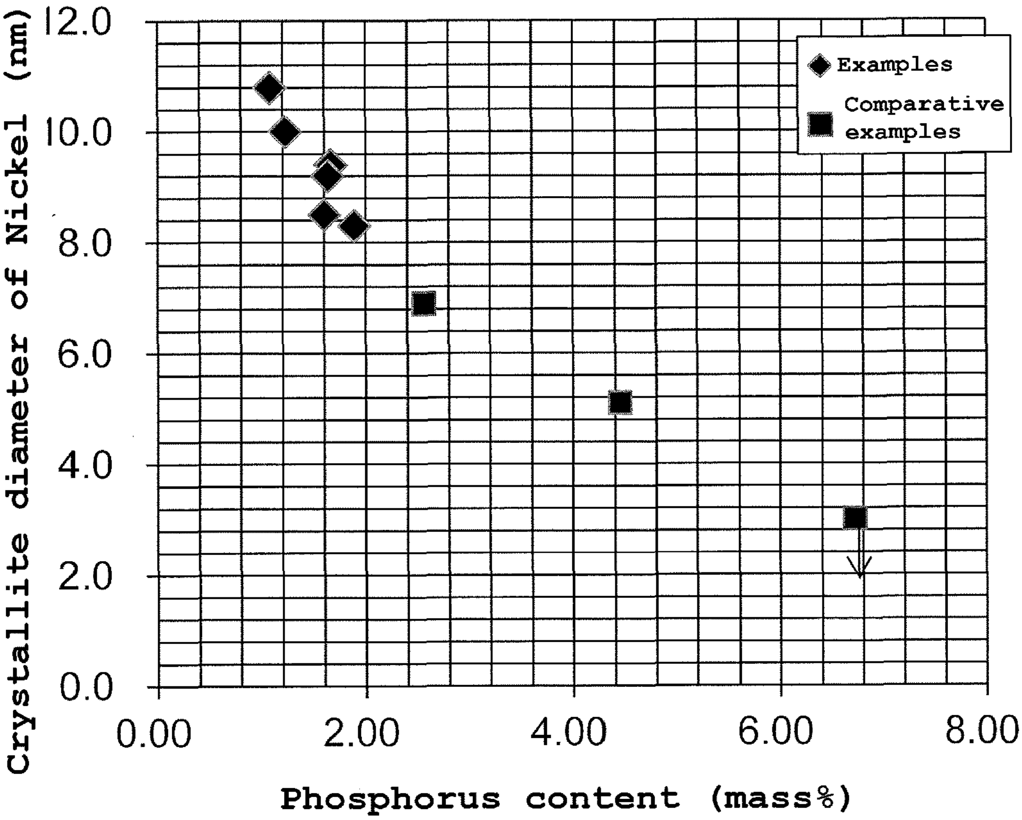
an underlayer between the base material and the electroless nickel plating layer,
wherein the underlayer is an electroless nickel plating layer containing 6.0 mass% to 11.0 mass% of phosphorus (P), and is a non-heat treated layer.

6. The sliding member for a compressor according to claim 5, wherein the underlayer does not contain boron (B) and cobalt (Co) .

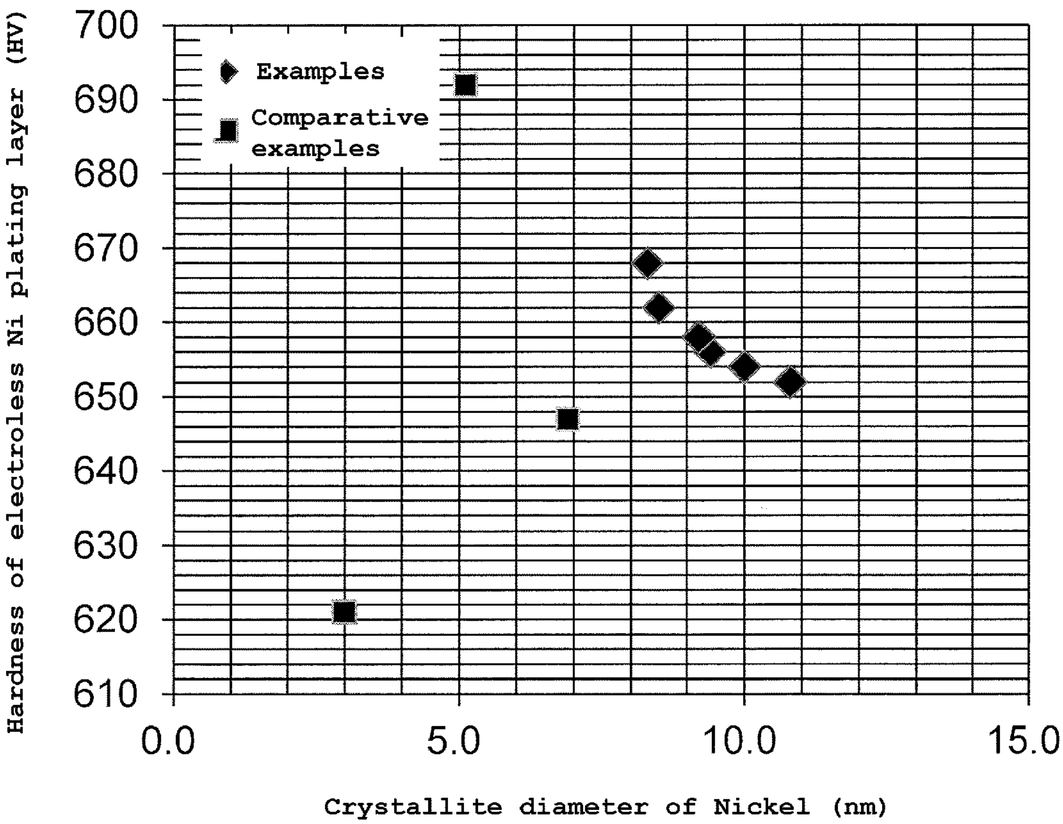
7. The sliding member for a compressor according to any one of claims 1 to 6, wherein a film thickness of the electroless nickel plating layer formed on the surface of the base material or a total film thickness of the underlayer formed on the surface of the base material and the electroless nickel plating layer is 15 μm to 30 pm.

8. The sliding member for a compressor according to any one of claims 1 to 7, wherein the electroless nickel plating layer is a non-dispersion plating film where ceramic particulates do not disperse in the layer.

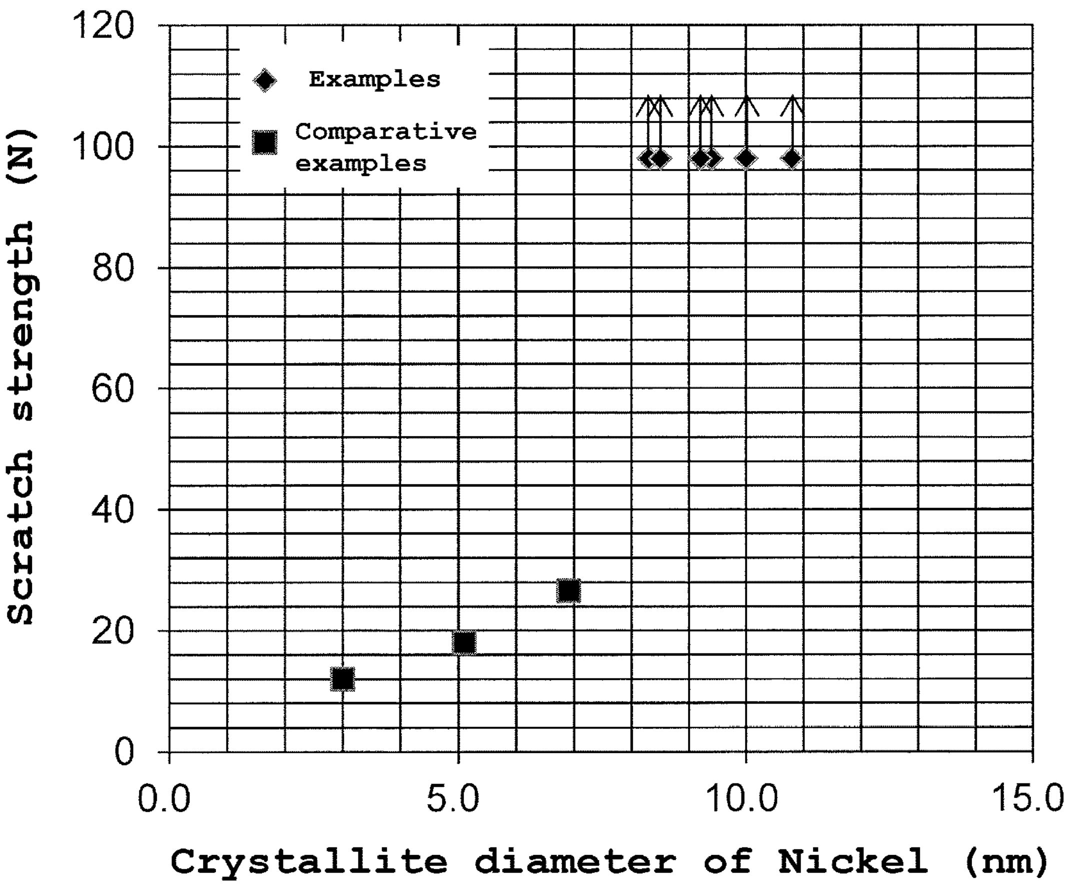
[FIG. 1]


Crystallite diameter of Nickel (nm)
12.0
10.0
8.0
6.0
4.0
2.0
0.0
0.00
2.00
4.00
6.00
8.00
Phosphorus content (mass%)
Examples
Comparative examples

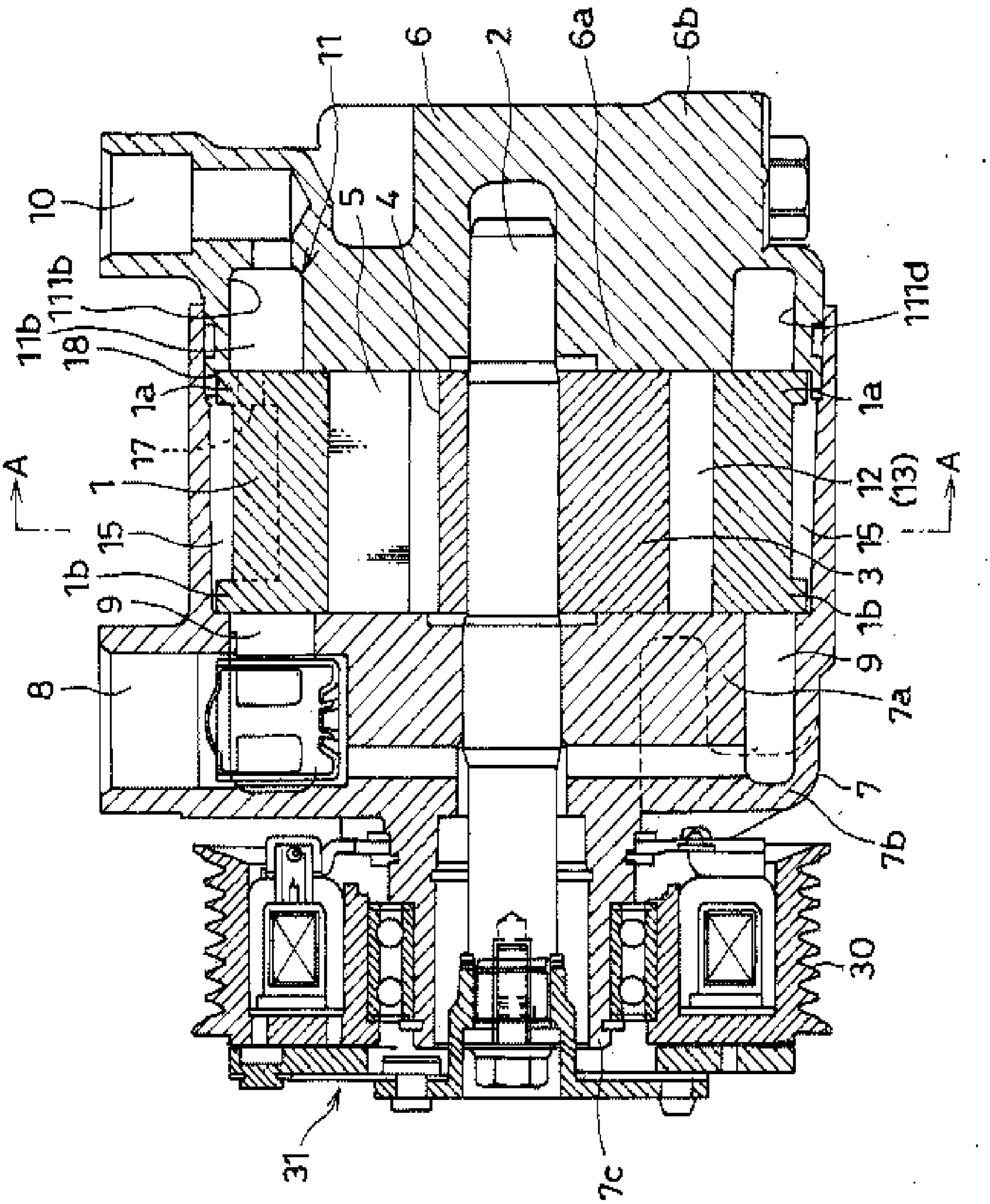
[FIG. 2]


Examples
Comparative examples
Hardness of electroless Ni plating layer (HV)
700
690
680
670
660
650
640
630
620
610
0.0
5.0
10.0
15.0
Crystallite diameter of Nickel (nm)

[FIG. 3]

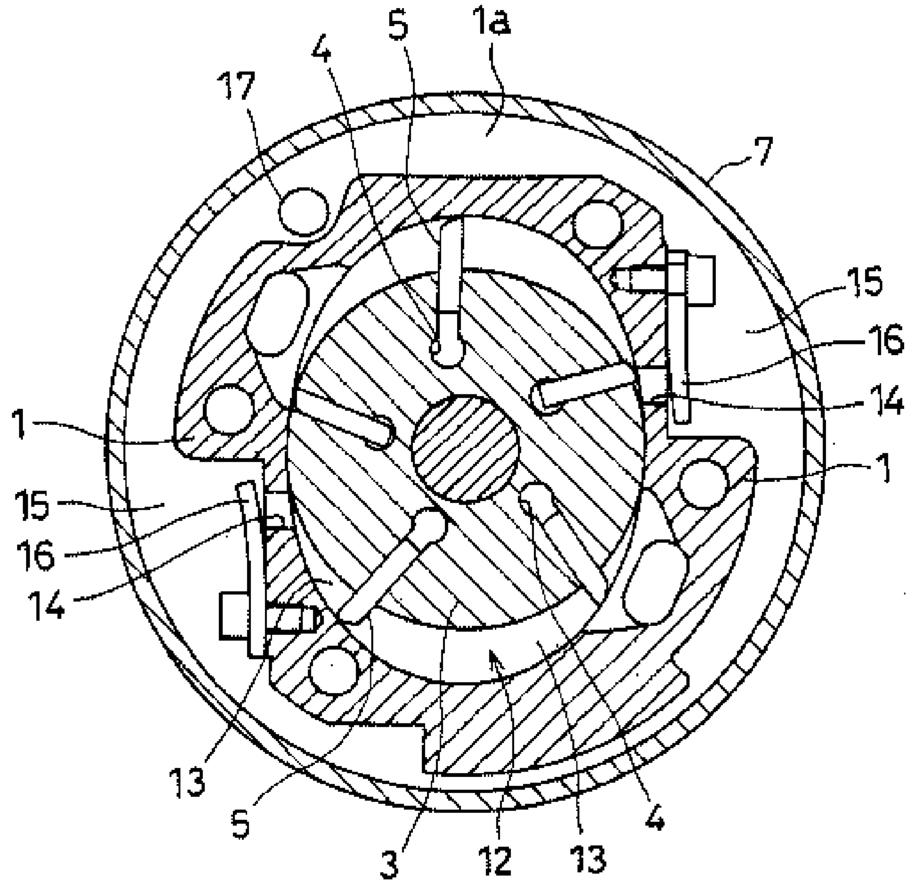

Scratch strength (N)
120
100
80
60
40
20
0
Examples
Comparative examples
0.0
5.0
10.0
15.0
Crystallite diameter of Nickel (nm)

[FIG. 4]



A
A
1
1a
1a
1b
1b
2
3
4
5
6
6a
6b
7
7a
7b
7c
8
9
9
10
11
11b
111b
111d
12
(13)
15
15
17
18
30
31

[FIG. 5]



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EUROPEAN SEARCH REPORT

Application Number
EP 18 19 6195

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	JP H10 96084 A (TAIHO KOGYO CO LTD) 14 April 1998 (1998-04-14) * paragraph [0001]; tables 1, 2 * * paragraph [0003] * * paragraph [0005] - paragraph [0006] * * paragraph [0015] * -----	1-8	INV. C23C18/16 C23C18/36 F02F3/10
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			C23C F02F

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
The Hague	12 December 2018	Telias, Gabriela

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12-12-2018

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