(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 910 334 A1

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
26.08.2015 Bulletin 2015/35

(21) Application number: **13844066.4**

(22) Date of filing: **01.10.2013**

(51) Int Cl.:
B24B 37/015 *(2012.01)*

(86) International application number:
PCT/JP2013/076647

(87) International publication number:
WO 2014/054611 (10.04.2014 Gazette 2014/15)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

(30) Priority: **03.10.2012 JP 2012221448**

(71) Applicant: **Fujimi Incorporated**
Kiyosu-shi, Aichi 452-8502 (JP)

(72) Inventors:
- **MORINAGA, Hitoshi**
  Kiyosu-shi
  Aichi 452-8502 (JP)
- **TAMAI, Kazusei**
  Kiyosu-shi
  Aichi 452-8502 (JP)
- **NIWANO, Yutaka**
  Kiyosu-shi
  Aichi 452-8502 (JP)
- **ASAI, Maiko**
  Kiyosu-shi
  Aichi 452-8502 (JP)

(74) Representative: **Grünecker Patent- und Rechtsanwälte**
PartG mbB
Leopoldstraße 4
80802 München (DE)

(54) POLISHING METHOD AND METHOD FOR PRODUCING ALLOY MATERIAL

(57) The polishing method polishes an alloy material using a polishing pad and a polishing composition supplied to the polishing pad. The polishing composition contains an abrasive of silica or alumina, and a surface temperature of the polishing pad at the end of polishing is 20°C or below. The method for producing an alloy material comprises a polishing step of polishing an alloy material using a polishing pad and a polishing composition supplied to the polishing pad. The polishing composition contains an abrasive of silica or alumina, and a surface temperature of the polishing pad at the end of polishing is 20°C or below.

EP 2 910 334 A1

Description

TECHNICAL FIELD

[0001] The present invention relates to a method for polishing an alloy material and a method for producing an alloy material.

BACKGROUND ART

[0002] Alloy materials have been used in various applications since alloy materials have higher mechanical strength, as well as higher chemical resistance, corrosion resistance and heat resistance compared to pure metal materials. Alloy materials are subjected to processing, e.g., polishing (see Patent Documents 1 and 2).

PRIOR ART DOCUMENTS

Patent Documents

[0003]

Patent Document 1: Japanese Laid-Open Patent Publication No. 01-246068

Patent Document 2: Japanese Laid-Open Patent Publication No. 03-228564

SUMMARY OF THE INVENTION

Problems to be Solved by the Invention

[0004] The object of the present invention is to provide a polishing method capable of easily improving the smoothness of a polished surface of an alloy material, and a method for producing an alloy material.

Means for Solving the Problems

[0005] In order to solve the problem described above, according to an aspect of the present invention, there is provided a method for polishing an alloy material using a polishing pad and a polishing composition supplied to the polishing pad, wherein the polishing composition contains an abrasive of silica or alumina, and wherein the surface temperature of the polishing pad at the end of polishing is 20°C or below.

[0006] Preferably, in the polishing method, an object to be polished is a machined surface or a surface pre-polished after machining.

[0007] Preferably, the alloy material is mainly composed of any one of magnesium, aluminum, titanium, chromium and iron.

[0008] Preferably, the alloy material is mainly composed of aluminum and contains at least one metal element selected from silicon, magnesium, iron, copper and zinc in an amount of 0.5% by mass or more.

[0009] In another aspect of the present invention, there is provided a method for producing an alloy material comprising a polishing step of polishing an alloy material using a polishing pad and a polishing composition supplied to the polishing pad, wherein the polishing composition contains an abrasive of silica or alumina, and wherein the surface temperature of the polishing pad at the end of polishing is 20°C or below.

EFFECTS OF THE INVENTION

[0010] The present invention can easily provide an improved smoothness for the polished surface of an alloy material.

EMBODIMENTS OF THE INVENTION

[0011] Hereinafter, there will be described an embodiment of the polishing method and the method for producing an alloy material.

[0012] The polishing method of the present embodiment polishes an alloy material using a polishing pad and a polishing composition supplied to the polishing pad. The polishing composition contains an abrasive of silica or alumina. The surface temperature of the polishing pad at the end of polishing is 20°C or below.

[0013] The polishing pad may be any of a polyurethane type, a nonwoven type, and a suede type, which may or may not contain an abrasive.

[0014] When a high polishing rate is required, it is preferred to use a relatively hard polishing pad, e.g., of a polyurethane type or a nonwoven type, particularly containing an abrasive.

[0015] When occurrence of defects is desired to be minimized on the polished surface of the alloy material or the alloy to be polished is soft and easy to be damaged, it is preferred to use a softer polishing pad, e.g., of a suede type not containing an abrasive.

[0016] The abrasive of silica (silicone oxide) or alumina (aluminum oxide) functions to physically polish the surface of the alloy material. Therefore, when using the polishing composition containing the abrasive of silica or alumina, the polishing rate is enhanced for the alloy material. In addition, when using the polishing composition containing the abrasive of silica or alumina, a smoother polished surface is easily attained.

[0017] Preferably, the mean primary particle diameter of the abrasive contained in the polishing composition is 5 nm or more, more preferably 10 nm or more, and still more preferably 15 nm or more. The larger the mean primary particle diameter of the abrasive, the higher the polishing rate that can be attained.

[0018] Preferably, the mean primary particle diameter of the abrasive contained in the polishing composition is 400 nm or less, more preferably 300 nm or less, and still more preferably 200 nm or less. The smaller the mean primary particle diameter of the abrasive, the more the smoothness of the polished surface improves.

[0019] The mean primary particle diameter of the abrasive can be calculated from the measured value of the specific surface area thereof by the nitrogen adsorption method (BET method).

[0020] Preferably, the content of the abrasive in the polishing composition is 1% by mass or more, and more preferably 2% by mass or more. The higher the content of the abrasive, the higher the polishing rate that can be attained.

[0021] Preferably, the content of the abrasive in the polishing composition is 50% by mass or less, and more preferably 40% by mass or less. The lower the content of the abrasive, the lower the production cost of the polishing composition and the fewer the scratches generated on the polished surface. Moreover, the lower the content of the abrasive, the lower the amount of the abrasive left on the alloy material. That results in easier washing of the alloy material after polishing.

[0022] The polishing composition may contain an abrasive other than silica and alumina. Examples of the abrasives other than silica and alumina include zirconia (zirconium oxide), ceria (cerium oxide), titania (titanium oxide), chromium oxide, iron oxide, silicon carbide, and silicon nitride.

[0023] Preferably, the pH of the polishing composition is between 8.0 and 12.0, further preferably between 9.5 and 11.2.

[0024] The alloy material contains a first metal species as a main component and a second metal species which is of different kind from the first metal species. Alloys are named based on the first metal species as the main component. Examples of the alloy materials include aluminum alloys, titanium alloys, stainless steels (mainly composed of iron), nickel alloys, and copper alloys.

[0025] The aluminum alloy is mainly composed of aluminum and further contains at least one selected from, for example, silicon, iron, copper, manganese, magnesium, zinc, and chromium. The content of the metal(s) other than aluminum in the aluminum alloy is, for example, from 0.1 to 10% by mass. Examples of the aluminum alloys include those of 2000s, 3000s, 4000s, 5000s, 6000s, 7000s, and 8000s as the alloy Nos. described in the JIS (Japanese Industrial Standards) H4000:2006, JIS H4040:2006, and JIS H4100:2006.

[0026] The titanium alloy is mainly composed of titanium and further contains at least one selected from, for example, aluminum, iron, and vanadium. The content of the metal(s) other than titanium in the titanium alloy is, for example, from 3.5 to 30% by mass. Examples of the titanium alloys include those of the types 11-23, the type 50, the type 60, the type 61, and the type 80 as the types described in JIS H4600:2012.

[0027] The stainless steel is mainly composed of iron and further contains at least one selected from, for example, chromium, nickel, molybdenum, and manganese. The content of the metal(s) other than iron in the stainless steel is, for example, from 10 to 50% by mass. Examples of the stainless steels include SUS201, SUS303, SUS303Se, SUS304, SUS304L, SUS304NI, SUS305, SUS305JI, SUS309S, SUS310S, SUS316, SUS316L, SUS321, SUS347, SUS384, SUSXM7, SUS303F, SUS303C, SUS430, SUS430F, SUS434, SUS410, SUS416, SUS420J1, SUS420J2, SUS420F, SUS420C, and SUS631J1 as the codes of types described in JIS G4303:2005.

[0028] The nickel alloy is mainly composed of nickel and further contains at least one selected from, for example, iron, chromium, molybdenum, and cobalt. The content of the metal(s) other than nickel in the nickel alloy is, for example, from 20 to 75% by mass. Examples of the nickel alloys include those of NCF600, NCF601, NCF625, NCF750, NCF800, NCF800H, NCF825, NW0276, NW4400, NW6002, and NW6022 as the alloy Nos. described in JIS H4551:2000.

[0029] The copper alloy is mainly composed of copper and further contains at least one selected from, for example, iron, lead, zinc, and tin. The content of the metal(s) other than copper in the copper alloy is, for example from 3 to 50% by mass. Examples of the copper alloys include those of C2100, C2200, C2300, C2400, C2600, C2680, C2720, C2801, C3560, C3561, C3710, C3713, C4250, C4430, C4621, C4640, C6140, C6161, C6280, C6301, C7060, C7150, C1401, C2051, C6711, and C6712 as the alloy Nos. described in JIS H3100:2006.

[0030] Preferably, the alloy material is mainly composed of any one of magnesium, aluminum, titanium, chromium and iron. When the alloy material is mainly composed of aluminum, the alloy material preferably contains at least one selected from silicon, magnesium, iron, copper and zinc in an amount of 0.5% by mass or more.

[0031] Examples of the surface of the alloy material to be polished include a machined surface, a surface pre-polished after machining, and a ground surface.

[0032] In the polishing method, the alloy material and the polishing pad supplied with the polishing composition are relatively moved to each other in a state where the polishing pad is pressed against the alloy material. This polishing method is practiced by a polishing apparatus. The polishing apparatuses include, for example, a single-sided polishing apparatus and a double-sided polishing apparatus.

[0033] The polishing apparatus has a carrier to hold the alloy material, a platen to which the polishing pad is fixed, and a driving unit to relatively move the carrier and the platen to each other. The polishing apparatus further includes a supplying unit to supply the polishing composition to the polishing pad, and a pressurizing mechanism to pressurize the polishing pad against the alloy materials at a predetermined load. The platen has a cooling mechanism to cool the surface on which the polishing pad is fixed. The cooling mechanisms include that in which a cooling medium is distributed through the platen and that using a Peltier device. The polishing pad can be cooled by the platen provided with such a cooling mechanism.

[0034] The polishing apparatus polishes the alloy material by relatively moving the platen and the carrier to each other, while supplying the polishing composition to the polishing pad that is pressed against the alloy material. In general, both the platen and the carrier holding a plurality of alloy materials are rotationally driven. However, only one of the platen (polishing pad) and the carrier (alloy materials) may be rotationally driven. The polishing is started at the same time as the start of the rotational drive of at least one of the platen and the carrier. During the polishing, the surface temperature of the polishing pad is controlled by the cooling mechanism in the platen. The polishing is terminated by stopping the rotation of the platen and the carrier. The surface temperature of the polishing pad at the end of polishing is controlled at 20°C or below.

[0035] The surface temperature of the polishing pad refers to the temperature of the polishing pad surface in contact with the alloy material. The surface temperature of the polishing pad at the end of polishing is measured using an infrared thermometer immediately after the polishing is ended. The surface temperature of the polishing pad may exceed 20°C prior to the termination of the polishing.

[0036] However, it is preferred that the surface temperature of the polishing pad is maintained at 20°C or below from the start to the end of the polishing. Preferably, the surface temperature of the polishing pad is above 0°C in terms of maintaining the stability of the polishing composition.

[0037] Preferably, the surface temperature of the polishing pad is in the range of above 0°C to 15°C or below, and more preferably in the range of 5°C or above to 12°C or below.

[0038] The temperature of the polishing composition supplied to the polishing pad is set so that the surface temperature of the polishing pad is maintained in the range described above. Preferably, the temperature of the polishing composition supplied to the polishing pad is 25°C or below in terms of facilitating setting of the surface temperature of the polishing pad.

[0039] The lower the smoothness of the surface to be polished, the longer period the polishing time is preferably set to. Preferably, the polishing time is 2 minutes or more, more preferably 3 minutes or more, and still more preferably 5 minutes or more in terms of improving the smoothness of the polished surface. A machined surface or a surface pre-polished after machining, for example, typically has low smoothness. Therefore, when such a surface is subject to polishing, the polishing time is set to 5 minutes or more. The upper limit of the polishing time is not particularly restricted, but preferably is, for example, not more than 120 minutes, and more preferably not more than 60 minutes in terms of retaining the efficiency by suppressing excessive polishing.

[0040] Typically, as the load between the alloy material and the polishing pad, i.e., the polishing load, increases, the physical force acting on the alloy material increases, which results in an enhancement of the polishing rate. Typically, as the polishing load decreases, the smoothness of the polished surface improves. Preferably, the polishing load is, for example, from 20 to 1,000 g/cm^2, more preferably from 50 to 500 g/cm^2.

[0041] The linear velocity in the polishing is typically adjusted depending on the rotational frequency of the polishing pad, the rotational frequency of the carrier, the size of the alloy material, the number of the alloy materials, and the like. Preferably, the linear velocity in the polishing is, for example, from 10 to 300 m/min, and more preferably from 30 to 200 m/min. The higher the linear velocity, the higher the polishing rate that can be attained. The lower the linear velocity, the more easily the friction force is applied to the alloy materials.

[0042] After the polishing is terminated, i.e., after the termination of the above rotational drive, the relative movement of the platen and the carrier to each other is terminated. In addition, the load applied between the platen and the carrier is released.

[0043] Hereinafter, the method for producing the alloy material will be described.

[0044] The method for producing the alloy material comprises a polishing step of polishing an alloy material using a polishing pad and a polishing composition supplied to the polishing pad. The polishing composition contains an abrasive of silica or alumina. The surface temperature of the polishing pad at the end of polishing is 20°C or below. Since the polishing step in the method for producing the alloy material is the same as the polishing method described above, the detailed description is omitted.

[0045] Then, with respect to the polishing method and the method for producing an alloy material, action thereof will be described.

[0046] When the polishing (polishing step) is started, the surface temperature of the polishing pad increases mainly due to the heat generated by the friction with the alloy materials. According to the present embodiment, the surface temperature of the polishing pad at the end of polishing is controlled to 20°C or below. That is, the surface temperature of the polishing pad is controlled so as to be lowered as the polishing is close to end thereof or so as to be maintained at 20°C or below throughout the polishing period.

[0047] A plurality of the metal species exhibit different reactivities in the polishing. The polished surface tends to be uneven due to this difference of the reactivities. However, it is speculated that the difference of the reactivities between the plurality of the metal species is reduced due to the temperature control of the polishing pad described above in the present embodiment, thereby improving the smoothness of the polished surface.

[0048] The machined surface has low smoothness and often has damage or burrs due to the processing. Thus, when the smoothness of the machined surface is improved by polishing, it would take a longer polishing time. Even when the machined surface has been pre-polished, for example, it may take a longer polishing time than a typical finish-polishing to improve the smoothness of the surface. That is, when the machined surface or the surface pre-polished after machining is polished, the polishing time tends to be set to a longer period of time. In this case, the polished surface is easily affected by increase in the surface temperature of the polishing pad, and as a result it becomes difficult to attain the desired smoothness even when the polishing time is set to a longer period of time. According to the method of the present embodiment where the surface temperature of the polishing pad is controlled, the machined surface or the surface pre-polished after machining can be polished to a smoother surface.

[0049] Preferably, the method according to the present embodiment is applied to a surface having a surface roughness value Ra of 20 nm or more, and more preferably is applied to a surface having a surface roughness value Ra of 30 nm or more. Preferably, the method according to the present embodiment is applied to attain a surface having a surface roughness value Ra of 10 nm or less, and more preferably is applied to attain a surface having a surface roughness value Ra of 5 nm or less. Preferably, the method according to the present embodiment is applied as finish-polishing to finish the alloy material surface since a polished surface having improved smoothness can be attained.

[0050] The applications of the alloy materials polished by the method described above are not particularly limited and the alloy materials can be used in various applications making good use of characteristics of the alloy materials. Examples of applications of aluminum alloys include structural materials such as building materials and containers; transportation machines such as automobiles, ships and aircraft; electrical appliances; and electronic components. Examples of applications of titanium alloys include precision instruments, ornaments, tools, sporting goods, and medical components. Examples of applications of stainless steels and nickel alloys include the above-described structural materials, transportation machines and tools, as well as machinery and cookware. Examples of applications of copper alloys include ornaments, tableware, musical instruments, and electric and electronic components.

[0051] According to the present embodiment described above in detail, the following effects are exerted.

(1) According to the polishing method of the present embodiment, the surface of the alloy material can easily be polished to provide an improved smoothness. Therefore, for example, an alloy material with a mirror surface excellent in gloss can easily be obtained. In addition, occurrence of defects on the polished surface can easily be suppressed.

(2) The polishing method of the present embodiment is particularly advantageous in that smoothness can be improved on the machined surface or the surface pre-polished after machining.

(3) The polishing method of the present embodiment is suitable for polishing an alloy material composed mainly of any one of magnesium, aluminum, titanium, chromium and iron. The polishing method of the present embodiment is particularly suitable for polishing an alloy material composed mainly of aluminum and containing at least one metal element selected from silicon, magnesium, iron, copper and zinc in an amount of 0.5% by mass or more.

(4) According to the method for producing an alloy material of the present embodiment, an alloy material having improved smoothness can easily be obtained. Therefore, for example, an alloy material with a mirror surface excellent in gloss can easily be obtained. In addition, occurrence of defects on the polished surface can easily be suppressed.

[0052] The embodiment described above may be modified as follows.

- The polishing composition may further contain a dispersant to enhance dispersibility of the abrasive as necessary. Examples of the dispersant include water-soluble polymers, water-soluble copolymers, and salts and derivatives thereof. Examples of the water-soluble polymers, the water-soluble copolymers, and salts and derivatives thereof include polycarboxylic acids such as polyacrylic acid salts; polyphosphoric acid; polysulfonic acids such as polystyrene sulfonic acid; polysaccharides such as xanthan gum and sodium alginate; cellulose derivatives such as hydroxyethyl cellulose and carboxymethyl cellulose; polyethylene glycol; polyvinyl alcohol; polyvinyl pyrrolidone; nonionic surfactants, and anionic surfactants. Specific examples of the nonionic surfactants include polyoxyethylene alkyl ethers, polyoxyethylene alkyl phenyl ethers, sorbitan monooleate, oxyalkylene-based polymers having one or more oxyalkylene units. Specific examples of the anionic surfactants include alkyl sulfonic acid-based compounds, alkylbenzene sulfonic acid-based compounds, alkylnaphthalene sulfonic acid-based compounds, methyltaurine-based compounds, alkyl diphenyl ether disulfonic acid-based compounds, α-olefin sulfonic acid-based compounds, naphthalene sulfonic acid condensates, sulfosuccinic acid diester-based compounds.

- The polishing composition may further contain other additives such as a pH adjusting agent, an etching agent, an oxidizing agent, an anticorrosive, a chelating agent, a dispersing auxiliary, a preservative, and an antifungal agent as necessary.

[0053] The pH adjusting agent used here can be any of known acids, bases and salts thereof. Specific examples of the acids usable for the pH adjusting agent include inorganic acids such as hydrochloric acid, sulfuric acid, nitric acid, hydrofluoric acid, boric acid, carbonic acid, hypophosphorous acid, phosphorous acid, and phosphoric acid; and organic acids such as formic acid, acetic acid, propionic acid, butyric acid, valeric acid, 2-methylbutyric acid, n-hexanoic acid, 3,3-dimethylbutyric acid, 2-ethylbutyric acid, 4-methylpentanoic acid, n-heptanoic acid, 2-methylhexanoic acid, n-octanoic acid, 2-ethylhexanoic acid, benzoic acid, glycolic acid, salicylic acid, glyceric acid, oxalic acid, malonic acid, succinic acid, glutaric acid, adipic acid, pimelic acid, maleic acid, phthalic acid, malic acid, tartaric acid, citric acid, lactic acid, diglycolic acid, 2-furancarboxylic acid, 2,5-furandicarboxylic acid, 3-furancarboxylic acid, 2-tetrahydrofurancarboxylic acid, methoxyacetic acid, methoxyphenylacetic acid, and phenoxyacetic acid.

[0054] The bases usable for the pH adjusting agent include organic bases, such as amines such as aliphatic amines and aromatic amines, and quaternary ammonium hydroxides; alkali metal hydroxides such as potassium hydroxide; alkaline earth metal hydroxides, and ammonia.

[0055] Salts such as ammonium salts or alkali metal salts of the acids described above may be used as the pH adjusting agent in place of the acids described above or in combinations with the acids described above.

[0056] Examples of the etching agents include inorganic acids such as nitric acid, sulfuric acid and phosphoric acid; organic acids such as acetic acid, citric acid, tartaric acid and methanesulfonic acid; inorganic alkalis such as potassium hydroxide and sodium hydroxide; ammonia and organic alkalis such as amines and quaternary ammonium hydroxides.

[0057] Specific examples of the oxidizing agents include hydrogen peroxide, peracetic acid, percarbonates, urea peroxide, perchlorates, and persulfates, as well as oxoacids such as sulfuric acid, nitric acid and phosphoric acid and salts thereof.

[0058] Specific examples of the anticorrosives include, in addition to amines, monocyclic compounds, polycyclic compounds including condensed ring compounds and heterocyclic compounds such as pyridines, tetraphenylphosphonium salts, benzotriazoles, triazoles, tetrazoles, and benzoic acid.

[0059] Specific examples of the chelating agents include carboxylic acid chelating agents such as gluconic acid; amine chelating agents such as ethylenediamine, diethylenetriamine, and trimethyltetraamine; polyaminopolycarboxylic chelating agents such as ethylenediaminetetraacetic acid, nitrilotriacetic acid, hydroxyethylethylenediaminetriacetic acid, triethylenetetraminehexaacetic acid, diethylenetriaminepentaacetic acid; organic phosphonic acid chelating agents such as 2-aminoethylphosphonic acid, 1-hydroxyethylidene-1,1-diphosphonic acid, aminotri(methylenephosphonic acid), ethylenediaminetetrakis(methylenephosphonic acid), diethylenetriaminepenta(methylenephosphonic acid), ethane-1,1-diphosphonic acid, ethane-1,1,2-triphosphonic acid, methanehydroxyphosphonic acid, 1-phosphonobutane-2,3,4-tricarboxylic acid; phenol derivatives; 1,3-diketones; and amino acids.

[0060] Specific examples of the dispersing auxiliaries include condensed phosphate salts such as pyrophosphate salts and hexametaphosphate salts. Examples of the preservatives include sodium hypochlorite. Examples of the antifungal agents include oxazolines such as oxazolidine-2,5-dione.

- The polishing composition may be of one-pack type or multi-pack type composed of two or more of packs.

- Each ingredient contained in the polishing composition may be that has been filtered with a filter immediately before preparation of the polishing composition. In addition, the polishing composition may be filtered with a filter immediately before use. By the filtering treatment, coarse foreign matters in the polishing composition are removed, so that the quality is improved.

[0061] The material and the structure of the filter used for the filtering treatment described above are not particularly limited. Examples of the materials of the filter include cellulose, polyamides, polysulfone, polyethersulfone, polypropylene, polytetrafluoroethylene (PTFE), polycarbonate, and glass. Examples of the structure of the filter include a depth filter, a pleated filter, and a membrane filter.

- When the alloy material is polished using the polishing composition, the polishing composition which has been once used for the polishing may be recovered and reused for polishing the alloy material. Methods for reusing the polishing composition include, for example, a method in which the spent polishing composition exhausted from the polishing apparatus is once recovered in a tank, and then recycled into the polishing apparatus from the tank for use. The reuse of the polishing composition can reduce the amount of discharge of the polishing composition that would be waste fluid and the quantity of the consumed polishing composition. This is useful with respect to capability of reducing the environmental burden and suppressing the cost for polishing the alloy materials.

[0062] When the polishing composition is reused, each ingredient in the polishing composition is consumed or lost through the polishing. Thus, it is preferred to replenish each ingredient in the amount corresponding to the decrement thereof to the polishing composition. The ingredients to be replenished may be individually added to the polishing composition, or alternatively, added to the polishing composition in a state where a plurality of the ingredients are mixed at any ratio depending on the capacity of the circulating tank, the polishing conditions or the like. By replenishing each ingredient in the amount corresponding to the decrement thereof to the polishing composition to be reused, the composition of the polishing composition is retained, thereby allowing the polishing composition to sustainably exert function thereof.

- The polishing composition may be prepared by diluting a stock solution of the polishing composition with water.

- A pre-polishing step may be carried out as a preceding step of the polishing step, and an additional polishing step may be carried out as a succeeding step of the polishing step.

Examples

[0063] The embodiment described above will be more specifically illustrated below with Examples and Comparative Examples.
[0064] In Examples 1-6 and Comparative Examples 1-4, colloidal silica (mean primary particle diameter: 80 nm) was employed as an abrasive. The colloidal silica was diluted with water and the pH was adjusted to 10.2 with potassium hydroxide to prepare a polishing composition. The abrasive content in the polishing composition is 22% by mass in all the Examples and Comparative Examples. The mean primary particle diameter of the abrasive was calculated based on the specific surface area of the abrasive determined by the BET method using "Flow SorbII 2300" manufactured by Micromeritics Instrument Corporation and the density of the abrasive.
[0065] In the Examples and Comparative Examples, aluminum alloys set forth in the "Alloy material" column in Table 1 were polished with the polishing composition described above. The names of the aluminum alloys set forth in Table 1 are in accordance with JIS (Japanese Industrial Standards) H4020:2006. In the Examples and Comparative Examples, three pieces of each aluminum alloy having a face with dimensions of 32 mm x 32 mm were prepared. The face had been pre-polished so as to have a surface roughness Ra of about 50 nm and was used for surface polishing. The polishing conditions in the polishing step are set forth in Table 2. The surface temperature of the polishing pad was controlled by a cooling mechanism disposed in the platen.
[0066] In the polishing step, the surface temperature of the polishing pad, the polishing rate, and the surface roughness of the polished surface of the alloy material after the polishing step were determined as follows.

<Surface temperature of polishing pad>

[0067] The surface temperature of the polishing pad at the end of polishing was measured using an infrared thermometer. The surface temperature was measured at a position on the polishing pad immediately before the position goes over the alloy material with rotation of the platen, the position being spaced radially inwardly from the periphery of the polishing pad by a distance of one sixth of the polishing pad diameter. The results are set forth in the "Surface temperature of polishing pad" column in Table 1. In each Example and Comparative Example, the surface temperature of the polishing pad did not exceed the temperature set forth in Table 1 and was maintained at 5°C or above from the start to the end of the polishing.

<Polishing rate>

[0068] The weight of the alloy material before the polishing and that after the polishing were measured and the polishing rate was calculated from the weight difference between before and after the polishing. The results are set forth in the "Polishing rate" column in Table 1.

<Surface roughness>

[0069] The surface roughness of the polished surface of the alloy material after the polishing step, which is denoted by "Ra", was determined using a surface shape measuring instrument (trade name: ZYGO New View 5000 5032, manufactured by Zygo Corporation) with a measuring region set to 1.4 mm x 1.1 mm. It is noted that the "Ra" is a parameter indicating the average amplitude in the height direction of the roughness curve and indicates the arithmetical mean of the height of the alloy material surface in a certain visual field. The measurements are set forth in the "Surface roughness Ra" column in Table 1.

[Table 1]

	Alloy material	Surface temperature of polishing pad [°C]	Polishing rate [μm/min]	Surface roughness Ra [nm]
Example 1	A5052	8	0.09	3.9
Example 2	A5052	14	0.11	4.1
Example 3	A5052	19	0.12	4.2
Comparative Example 1	A5052	23	0.13	4.9
Comparative Example 2	A5052	30	0.15	5.1
Example 4	A6063	8	0.10	3.1
Example 5	A6063	14	0.11	3.5
Example 6	A6063	19	0.12	3.7
Comparative Example 3	A6063	23	0.12	4.2
Comparative Example 4	A6063	30	0.14	4.4

[Table 2]

Polishing conditions	
Polishing machine:	single-sided polishing machine (platen diameter: 380 mm)
Polishing pad:	suede type
Polishing load:	130 g/cm^2
Platen rotational frequency:	80 rpm
Linear velocity:	63.6 m/min
Polishing time:	10 min
Supply rate of polishing composition:	14 ml/min (used without recycling)

[0070] As shown in Table 1, the values of the surface roughness Ra of the alloy materials after the polishing in Examples 1-3 were smaller than those in Comparative Examples 1 and 2. The values of the surface roughness Ra of the alloy materials after the polishing in Examples 4-6 were also smaller than those in Comparative Examples 3 and 4. These results reveal that in each Example an alloy material having a polished surface with a smaller value of surface roughness Ra, i.e., an alloy material having a smoother polished surface can easily be obtained.

Claims

1. A method for polishing an alloy material using a polishing pad and a polishing composition supplied to the polishing pad, the method being **characterized in that**
the polishing composition contains an abrasive of silica or alumina, and
a surface temperature of the polishing pad at the end of polishing is 20°C or below.

2. The method according to claim 1, wherein an object to be polished is a machined surface or a surface pre-polished after machining.

3. The method according to claim 1 or 2, wherein the alloy material is mainly composed of any one of magnesium, aluminum, titanium, chromium and iron.

4. The method according to any one of claims 1-3, wherein the alloy material is mainly composed of aluminum and contains at least one metal element selected from silicon, magnesium, iron, copper and zinc in an amount of 0.5% by mass or more.

5. A method for producing an alloy material comprising a polishing step of polishing an alloy material using a polishing pad and a polishing composition supplied to the polishing pad, the method being **characterized in that**
the polishing composition contains an abrasive of silica or alumina, and
a surface temperature of the polishing pad at the end of polishing is 20°C or below.

INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2013/076647

A. CLASSIFICATION OF SUBJECT MATTER

B24B37/015(2012.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B24B37/00-37/34, H01L21/304

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	1996-2013
Kokai Jitsuyo Shinan Koho	1971-2013	Toroku Jitsuyo Shinan Koho	1994-2013

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2010-205796 A (Ebara Corp.), 16 September 2010 (16.09.2010), paragraph [0042] (Family: none)	1-5
Y	JP 2008-544868 A (Cabot Microelectronics Corp.), 11 December 2008 (11.12.2008), paragraphs [0012] to [0014], [0023] & US 2007/0010098 A1 & WO 2007/120163 A2 & KR 10-2008-0015471 A & CN 101208178 A & TWB 00I300735	1-5

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* 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

Date of the actual completion of the international search	Date of mailing of the international search report
18 December, 2013 (18.12.13)	07 January, 2014 (07.01.14)

Name and mailing address of the ISA/	Authorized officer
Japanese Patent Office	
Facsimile No.	Telephone No.

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2013/076647

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2006-150534 A (Kao Corp.), 15 June 2006 (15.06.2006), paragraphs [0017] to [0018], [0029] to [0030], [0038] to [0040] & US 2006/0112647 A1 & US 2008/0280538 A1 & GB 2421244 A & CN 1781971 A	1-5
Y	JP 2001-323254 A (Kao Corp.), 22 November 2001 (22.11.2001), abstract; claims 4; paragraphs [0002], [0021], [0031] to [0033] & US 2002/0028636 A1 & TW 526259 B & CN 1323864 A	1-5

Form PCT/ISA/210 (continuation of second sheet) (July 2009)

REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

- JP 1246068 A **[0003]**
- JP 3228564 A **[0003]**