



US 20090047170A1

(19) **United States**

(12) **Patent Application Publication**
Shoji et al.

(10) **Pub. No.: US 2009/0047170 A1**

(43) **Pub. Date: Feb. 19, 2009**

(54) **OXIDE-DISPERSION STRENGTHENED
PLATINUM MATERIAL**

(76) Inventors: **Toru Shoji**, Kanagawa (JP);
Seiichiro Tanaka, Tokyo (JP); **Seiji**
Takeishi, Kanagawa (JP); **Hideo**
Segawa, Kanagawa (JP)

Correspondence Address:
ROBERTS & ROBERTS, LLP
ATTORNEYS AT LAW
P.O. BOX 484
PRINCETON, NJ 08542-0484 (US)

(21) Appl. No.: **10/583,827**

(22) PCT Filed: **Oct. 6, 2005**

(86) PCT No.: **PCT/JP05/18519**

§ 371 (c)(1),
(2), (4) Date: **Jun. 19, 2006**

(30) **Foreign Application Priority Data**

Oct. 8, 2004 (JP) 2004-295598

Publication Classification

(51) **Int. Cl.**
C22C 5/04 (2006.01)

(52) **U.S. Cl.** **420/466**

(57) **ABSTRACT**

The present invention provides an oxide-dispersion-strengthened platinum material in which dispersed particles made from a metallic oxide of an additive metal are dispersed in a matrix made from platinum or a platinum alloy, characterized in that the concentration of oxygen in the material except oxygen bound to the additive metal is 100 ppm or lower. The platinum material according to the present invention has preferably an average diameter of the dispersed particles of 0.2 μm or smaller, and an average interparticle distance of 0.01 to 2.7 μm . The platinum material also preferably has the concentration of the dispersed particles in an amount of 0.01 to 0.5 wt %, and an oxidation rate of the additive metal of 50 to 100%.

Fig. 1

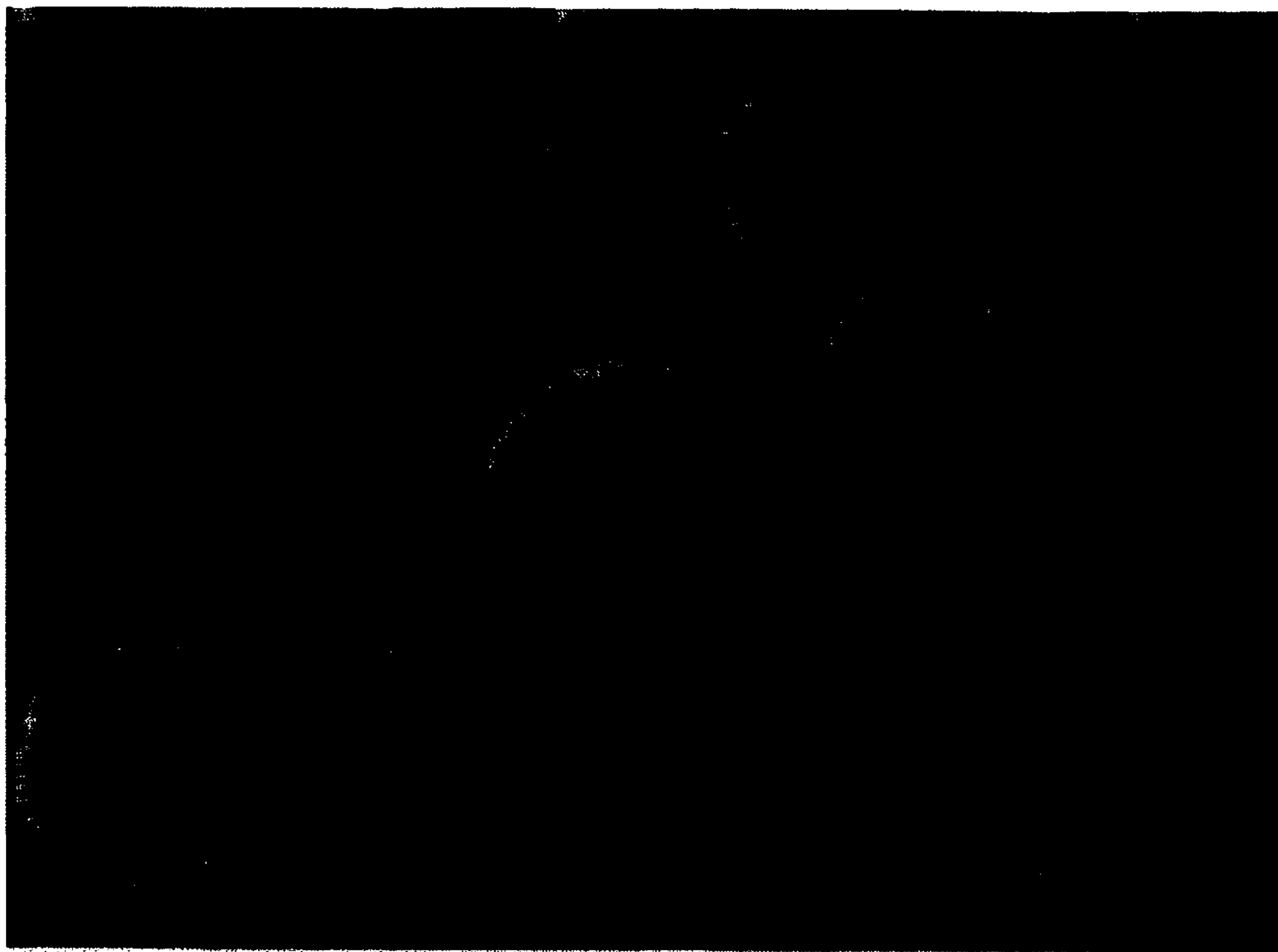


Fig. 2

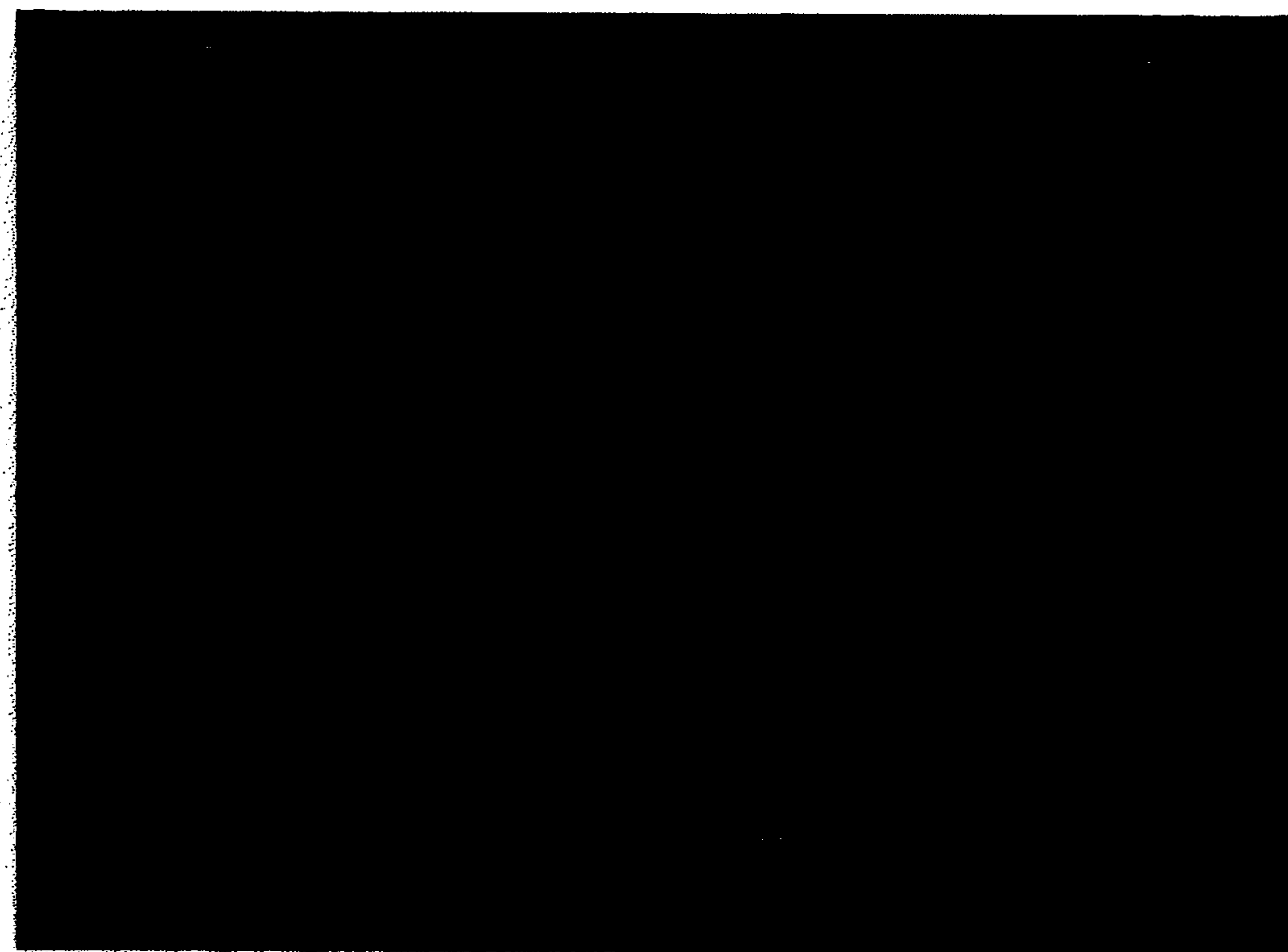


Fig. 3

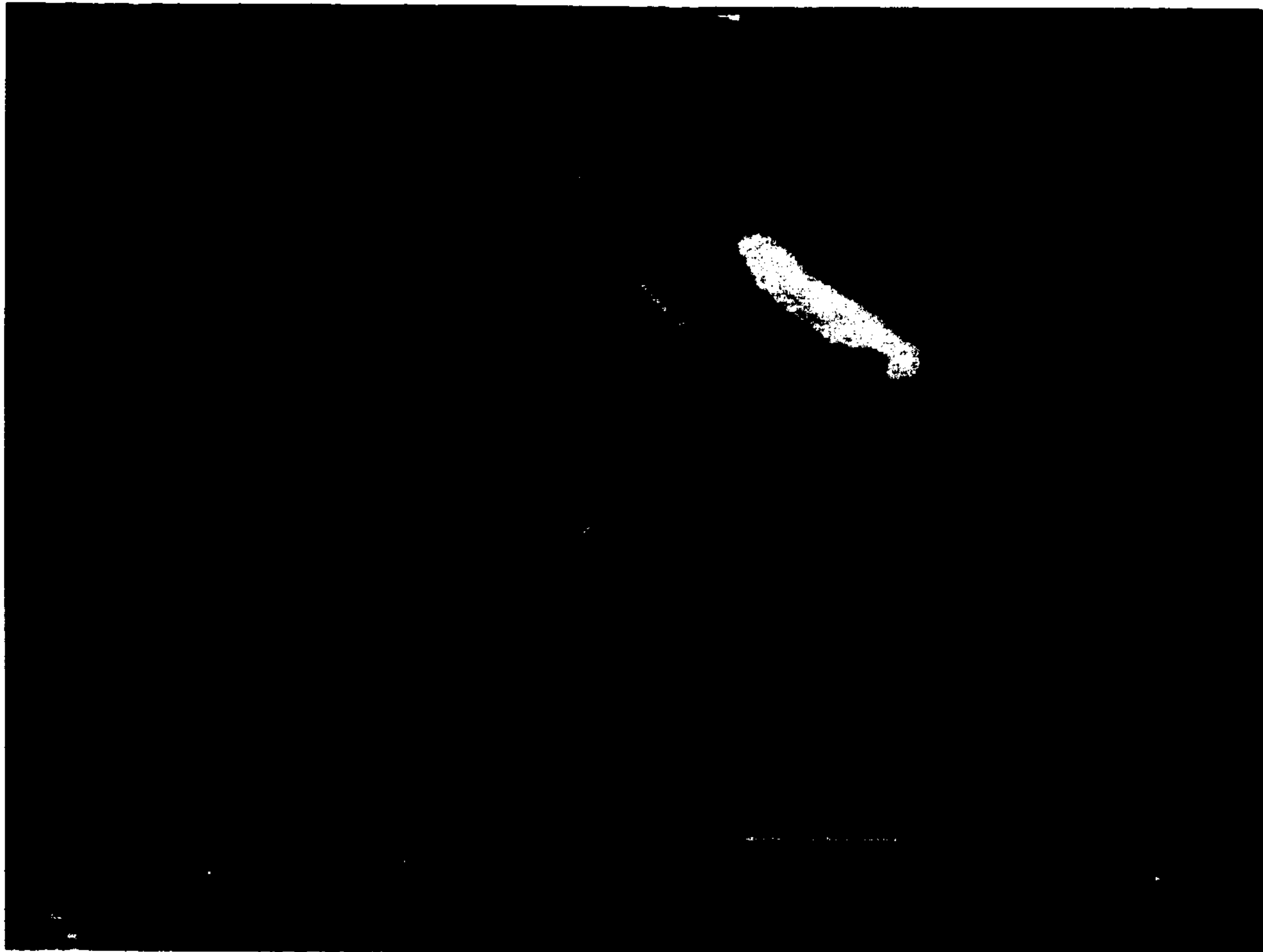


Fig. 4

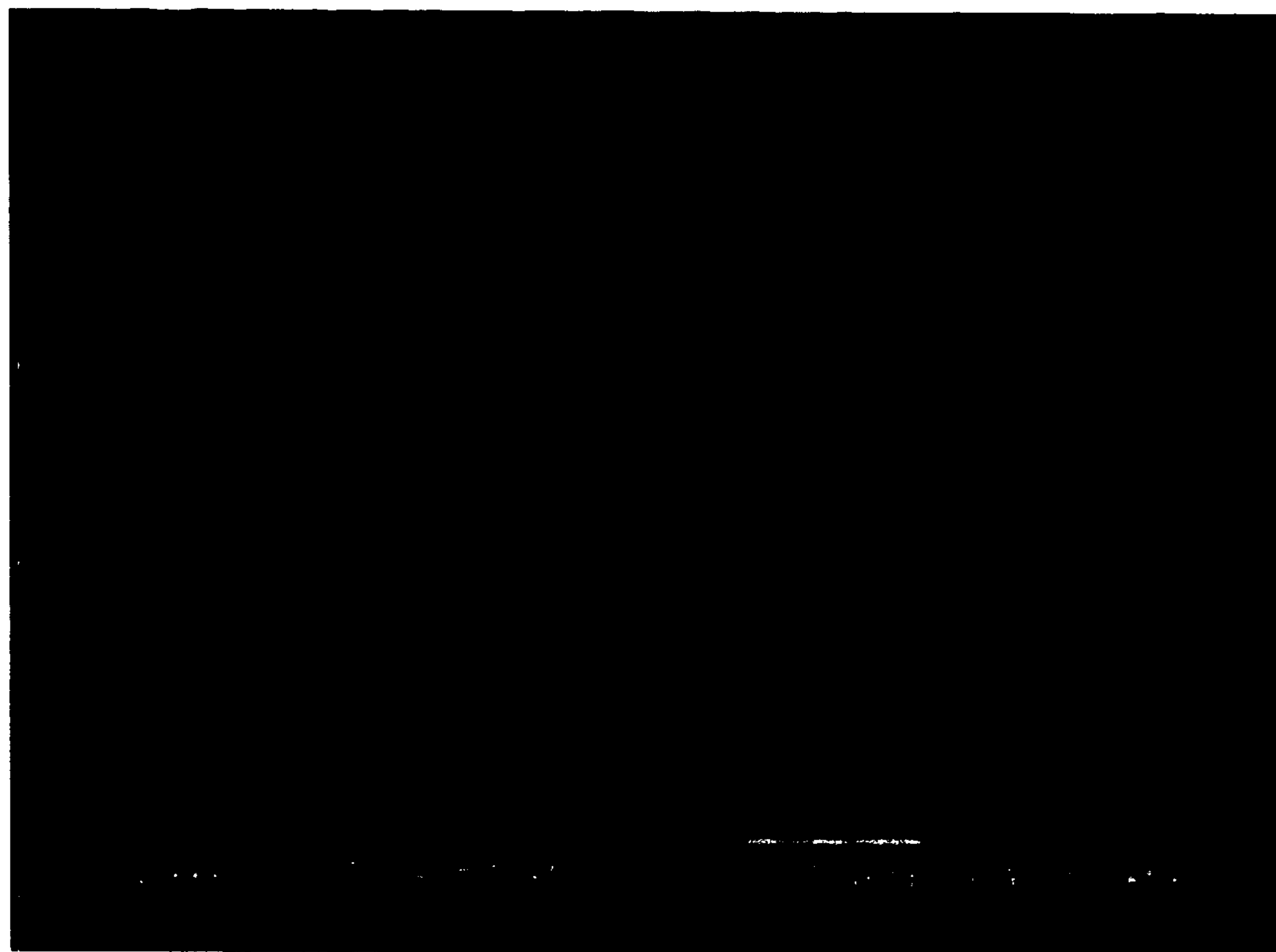
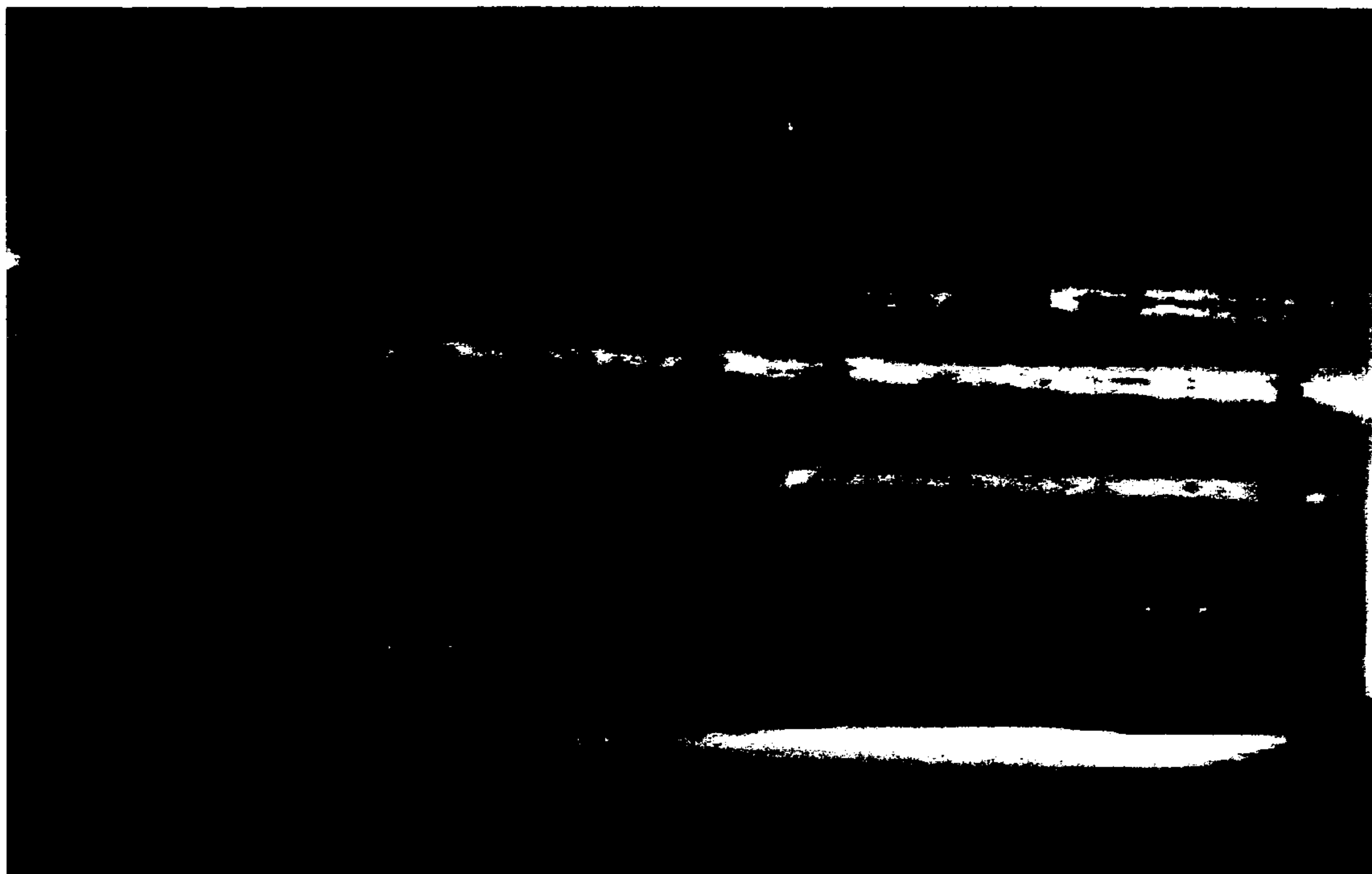


Fig. 5



OXIDE-DISPERSION STRENGTHENED PLATINUM MATERIAL

TECHNICAL FIELD

[0001] The present invention relates to an oxide-dispersion-strengthened platinum material in which oxides are dispersed in platinum or a platinum alloy, and particularly which can keep strength at high temperature for a long period, and has adequate weldability.

BACKGROUND ART

[0002] An oxide-dispersed platinum material in which metal oxides such as zirconium oxide (zirconia) are finely dispersed in platinum or platinum alloy has superior high-temperature strength characteristics, particularly, creep strength, and accordingly has been used for a structural material in a glass production apparatus which is used in an environment.

[0003] As a method for producing the oxide-dispersed platinum material, a powder metallurgy process has been generally employed. In the method, a platinum material is produced by preparing an alloy powder of platinum and zirconium, subjecting the alloy powder to oxidation treatment to internally oxidize zirconium in the alloy powder into zirconium oxide, thereby preparing a platinum powder in which zirconium oxides are finely dispersed, sintering it, and working it.

[0004] In addition, the present applicant has variously improved an oxide-dispersed platinum material in order to further increase high-temperature strength, and for instance, has disclosed the oxide-dispersed platinum material that makes the grain size of crystals and the aspect ratio of crystals in platinum or a platinum alloy optimized, which is a matrix, in addition to making dispersed particles finely dispersed. The platinum material is produced by the steps of: employing a mixture solution of a platinum suspended solution and a zirconium nitrate solution as a raw material; subjecting it to predetermined treatment to produce a platinum powder carrying zirconium hydroxide therein; compacting the platinum powder; and then heating it and working it to make dispersed particles comprising zirconium oxide, and at the same time to adjust grain sizes of crystals of a matrix.

[0005] [Patent Document 1:] Japanese Patent Application Laid-Open No. 2002-12926

[0006] As described above, an oxide-dispersed platinum material improves the high-temperature strength (creep strength) of the platinum material, and has a remarkable effect in this respect. However, the present inventors have been elucidated that these oxide-dispersed platinum materials have some points to be improved, though they are extremely excellent in terms of strength.

[0007] At first, stability when used in a high-temperature environment for a long period is pointed out as an improvement of an oxide-dispersed platinum material. In a glass-making apparatus using the platinum material, the atmospheric temperature occasionally reaches 1,500° C. or higher. The present inventors recognize that the oxide-dispersed platinum material may cause a void (cavity) or a blister (swelling) in the material, when exposed to such a high temperature for a long period. The problem of the blister tends to occur more often particularly in a material of a thin sheet. The void existing in the material can be a factor of decreasing the strength of the whole material.

[0008] In addition, an oxide-dispersed platinum material needs improvement in weldability as well. A glass-melting tank and the like are manufactured with the use of a welding technique, and the oxide-dispersed platinum material has a comparatively high possibility of causing a weld defect such as a blow hole in a junction after having been welded. The weld defect leads to a rupture of an apparatus if having been overlooked, and leaves a problem of yield even if having been discovered by inspection beforehand.

[0009] For this reason, an object of the present invention is to provide an oxide-dispersed platinum material which can be stably used at high temperatures and is superior in weldability as well.

DISCLOSURE OF THE INVENTION

[0010] The present inventors researched factors affecting the above described problems, and as a result, focused attention on the behavior of oxygen in a material, as the factor of producing a blister at a high temperature and a blow hole in welding.

[0011] Oxygen is an element which constitutes a dispersed particle and the constituent element indispensable for an oxide-dispersed alloy. However, an amount of oxygen in an oxide-dispersed platinum material generally exceeds the amount necessary to compose the dispersed particle, so that oxygen which is not bound to an additive metal exists in the material in an atomic form or a molecular form. The reason is considered to be because the material essentially needs to pass a step of treatment in high-temperature air in a production process, and in the step, excessive oxygen can be possibly introduced into the material.

[0012] Then, oxygen in an atomic form or a molecular form, which is not bound to an additive metal, diffuses and aggregates in a material into gaseous oxygen in a high-temperature environment and forms a void and a blister. In addition, the oxygen in the atomic form and the molecular form expands its volume when a material is melt during welding, and becomes a blow hole which is likely to remain in the material.

[0013] The present inventors researched a proper range of oxygen concentration in an oxide-dispersed platinum material on the basis of the above described discussion, and conceived the present invention.

[0014] Specifically, the present invention provides an oxide-dispersion-strengthened platinum material in which dispersed particles made from a metallic oxide of an additive metal are dispersed in a matrix made from platinum or a platinum alloy, characterized in that the concentration of oxygen in the material except oxygen bound to the additive metal is 100 ppm or lower.

[0015] The reason why the concentration of oxygen which does not constitute a dispersed particle (hereafter referred to as the concentration of excessive oxygen occasionally) is set to be 100 ppm or lower in the present invention is that when oxygen of more than 100 ppm exists in a matrix, it is remarkably converted into gaseous oxygen at a high temperature or while a material melts, and tends to produce a blister or a blow hole. The oxygen concentration is more preferably 50 ppm or lower, and the closer is the oxygen concentration to 0 ppm, the better is the performance. For information, the concentration of excessive oxygen in an oxide-dispersed platinum material conventionally on the market is 150 ppm or higher.

[0016] Here, as for a method of calculating the concentration of excessive oxygen, it can be calculated by determining

a difference between the oxygen concentration in the whole platinum material and a product of the oxygen concentration theoretically determined by the concentration of an additive metal multiplied by the oxidation rate of the additive metal described below. The concentration of oxygen in the whole platinum material can be measured by heating the platinum material to a temperature of about 3,000° C. in a carbon crucible by passing an electric current through the platinum material to melt it, and analyzing the quantity of carbon dioxide gas generated therefrom by oxygen concentration analysis for quantitative analysis or by device analysis such as GD-MS.

[0017] The concentration of excessive oxygen can be also calculated by subtracting the concentration of oxygen bound to an additive metal from the concentration of oxygen in the whole platinum material. Here, the concentration of oxygen bound to the additive metal can be calculated by the steps of: slowly heating the platinum material to about 3,000° C., when analyzing the concentration of oxygen in the above described whole platinum material; detecting an amount of generated oxygen at each temperature on the way; distinguishing a peak detected in the vicinity of the melting point of platinum from the peak of oxygen derived from an oxide of an additive metal, which is detected at 2,500° C. or higher; and quantifying the amount of oxygen in the latter oxygen peak.

[0018] In the meantime, it is the most effective means in the present invention to regulate the concentration of oxygen in a platinum material, however according to the present inventors, in addition to this, it is also effective means to specify a condition of dispersed particles. A strengthening mechanism in a particle-dispersed alloy is not affected by an amount (volume fraction) of the dispersed particles, but affected by the fineness of the dispersed particles even though the amount of them are very small. As described in the above described Patent Document 1, particularly, the strength of a particle-dispersed platinum material increases with the increase of an aspect ratio of a crystal grain, and the aspect ratio is affected by an average value of distances among the dispersed particles. Specifically, in order to secure weldability while making the strengthening mechanism sufficiently developed in the particle-dispersed alloy, it is preferable to make fine dispersed particles uniformly dispersed into a highly dispersed condition.

[0019] From such a viewpoint, a platinum material according to the present invention preferably has an average diameter of dispersed particles of 0.2 μm or smaller, and an average value of distances between the particles of 0.01 to 2.7 μm . The reason why the average particle diameter of the dispersed particle is set to be 0.2 μm or smaller is that the platinum material needs to disperse particles as fine as 0.2 μm or smaller for sufficiently strengthening itself, while considering the particle diameter of the manufacturable dispersed particles. Furthermore, the reason why a range of the average value of distances among the particles is set is to improve an aspect ratio of the crystal grains in a platinum matrix and secure an effect of improving strength.

[0020] On the other hand, the platinum material preferably contains dispersed particles in an amount (concentration) of 0.01 to 0.5 wt %. The amount of the dispersed particles does not affect the weldability of an alloy, but has the minimum value for developing an effect of improving strength due to dispersed particles; and affects workability (deep drawability and ductility) of the alloy. The reason why the concentration of the dispersed particles is set to be 0.01 to 0.5 wt % in the

present invention is that the minimum required concentration for making dispersed particles show the effect of increasing strength is 0.01 wt %; and that an amount of more than 0.5 wt % is unfavorable from the perspective of preventing aggravation of the workability. Here, when the alloy is used in the application which does not require much deep drawability and ductility such as in the case of working to make a bushing base plate or the like, the concentration of the dispersed particles is preferably in the above described range, and may be 0.3 wt % and 0.4 wt % as long as it is in the range. On the other hand, when the alloy is used in the application which requires the deep drawability and the ductility such as in the case of working a large-sized platinum apparatus, the concentration of the dispersed particles is preferably 0.01 to 0.14 wt % so as to further enhance the workability, and thus an upper limit value is preferably further reduced.

[0021] In addition, when a dispersed state and the amount of dispersed particles is in the above described range, all the additive metals in a platinum material do not always need to be in a state of oxide. For instance, as described above, there is a method for producing the particle-dispersed platinum material by oxidizing a platinum alloy powder to oxidize the additive metal and form the dispersed particle, and in this case, not all the additive metals need to be converted into the oxide in the oxidizing treatment, but a necessary amount of the dispersed particles has only to be finely dispersed.

[0022] Then, an oxidation rate of an additive metal is preferably 50 to 100%. The oxidation rate indicates a ratio of an atomic number (mole number) of the additive metal which has been converted into an oxide, with respect to the atomic number (mole number) of the additive metal in a platinum material. The reason why the oxidation rate is set to be 50 to 100% is that when the strengthened platinum material is used at high temperature, oxygen in the atmosphere diffuses into the platinum material, which promotes so-called internal oxidation. The diffusion of oxygen in this case occurs preferentially in a crystal grain boundary, and the additive metal diffuses and precipitates in the crystal grain boundary into which oxygen preferentially diffuses. The reason why the lower limit of the oxidation rate is necessary to be set at 50% is that when a large amount of the additive metal precipitates in the crystal grain boundary in the above step, the material is embrittled. The oxidation rate can be calculated in the formula of (amount of additive metal having formed oxide)/(amount of additive metal) \times 100. The amount of the additive metal having formed the oxide can be determined by dissolving a platinum material in aqua regia or a solution of hydrochloric acid and chlorine, separating a residue by filtrating the solution, weighing the residue, and measuring the amount of the additive metal oxide.

[0023] In an oxide-dispersed platinum material according to the present invention, a preferred additive metal includes calcium, yttrium and samarium in addition to zirconium. The oxides of these metals stably exist in the platinum material, and can develop an effect of improving the strength when dispersed in the material as a particle.

[0024] In addition, the matrix may be a platinum alloy in addition to (pure) platinum. A preferred platinum alloy includes a platinum-rhodium alloy, a platinum-gold alloy, a platinum-rhodium-gold alloy and a platinum-iridium alloy.

[0025] In the next place, a method for producing a platinum material according to the present invention will be described. The oxide-dispersed platinum material according to the present invention basically has a feature of limiting the con-

centration of oxygen contained in the material, so that a conventional production method can be adapted for producing it as long as it can reduce oxygen concentration. Specifically, for instance, the method of internally oxidizing a platinum alloy powder, and compacting and solidifying it makes excessive oxygen not to enter into the material by adjusting an internal oxidation condition. In addition, as the method according to Patent Document 1, the method of compacting and solidifying a platinum powder carrying the hydroxide of an additive metal therein and heat-treating it to form a dispersed particle also makes excessive oxygen not to enter into the material, by controlling the heat treatment condition.

[0026] However, even though the method of adjusting these conditions of internal oxidation treatment and heat treatment is employed, there may be cases where it is difficult to definitely set the conditions. In addition, the internal oxidation treatment and the heat treatment need to be carried out at high temperatures, then are feared growing the oxide because of being carried out in a high-temperature atmosphere, and accordingly hardly make formed dispersed particles into an ideally dispersed state.

[0027] For this reason, the present inventors concluded that a comparatively low temperature process is preferable for producing an oxide-dispersed platinum material according to the present invention, and found a specific method of stirring a platinum alloy powder or an alloyed wire material (hereafter may be abbreviated merely as powder occasionally) in water accommodated in a high-energy dispersion mill such as an attritor, and oxidizing an additive metal in the alloy with the water (oxygen of constituting water).

[0028] In this process, a powder which has been stirred in a high-energy dispersion mill is repeatedly pulverized, compressed and agglutinated through receiving a high-energy impact. In the process, the powder exposes a new surface when being pulverized, and the new surface is active and in a state to be easily oxidized. Accordingly, when water is arranged as an atmosphere around the alloy of being stirred, the exposed new surface of an alloy is oxidized by the water; and the oxidation reaction in the high-energy dispersion mill can proceed even not at high temperatures. Accordingly, the method hardly causes a problem of grain growth because it can oxidize the alloy even at ordinary temperatures, and can disperse oxide particles into an ideal state.

[0029] The production method begins by producing an alloy powder or an alloyed wire material consisting of platinum and an additive metal. A preferred method for producing the alloy powder includes an atomization method (gas atomization or water atomization) using a molten alloy with a predetermined composition as a raw material. This is because the atomization method can easily adjust a melting atmosphere and provide a preferable powder while preventing the oxidation of the additive metal. The alloy powder to be produced here preferably has a particle diameter of 300 μm or smaller. This is because when the alloy powder with a particle diameter of larger than 300 μm is employed, it takes a long period to subsequently treat the alloy powder in a high-energy dispersion mill. When an alloyed wire material is employed, it is manufactured by subjecting a melt and cast alloy block to wire drawing, drawing or the like. At this time, it may be appropriately cut so as to be introduced into a device.

[0030] After an alloy powder has been produced, the alloy powder is introduced into a high-energy ball mill together with water, and is stirred to oxidize an additive metal in the alloy powder. The high-energy ball mill is a device having a

vessel filled with steel balls or ceramic balls of pulverizing media and having a stirring blade further arranged therein, and includes, for instance, a Dynor mill and an Ultra Visco mill in addition to an attritor, as a well known device.

[0031] It is necessary to select a component material of a high-energy ball mill while considering contamination originating from the component material of a device during high-energy stirring. In the present invention, a preferred material is ceramic, and particularly zirconia. This is because the component material hardly contaminates the powder, and gives the least influence to material properties even when having contaminated the powder. In addition, a pulverizing medium preferably has a diameter of 1 to 10 mm. This is because, when the pulverizing medium has a smaller diameter than 1 mm, the device needs to rotate a stirring blade at high speed in order to compensate for decrease in a pulverizing power, and has difficulty in separating the powder and the pulverizing medium after having finished oxidation treatment. In addition, that is because, when the pulverizing medium has a larger diameter than 10 mm, a torque necessary for rotation excessively increases, which further easily damages a vessel and a stirring blade. It is preferable to set an amount of the filled pulverizing medium at 50% of a vessel capacity as a measure, but the amount hardly causes a detrimental effect unless excessively exceeding the value.

[0032] Water to be introduced into a high-energy ball mill together with an alloy is preferably of high purity, and is particularly preferably ultrapure water. This is because when impurities are contained in water being used in oxidation treatment, the impurities adhere to a powder, consequently are included in an oxide-dispersed alloy to be produced, cause gas generation while the alloy containing the impurities is used at a high temperature, and are feared causing strength degradation. In addition, it is preferable to charge water in such a level as to immerse the powder thereunder. This is because a new active surface formed by high-energy stirring in an attritor can be reliably contacted with water. An atmospheric gas in a vessel may be air, but is preferably oxygen. This is because a material is prevented from containing nitrogen in the air.

[0033] In addition, in this method, an additive metal is oxidized by stirring in a high-energy ball mill, but it is also acceptable to subsequently further oxidize the alloy powder by heating it in an oxidative atmosphere, as long as the final concentration of excessive oxygen is controlled to 100 ppm or less. The heating step is carried out so as to additionally oxidize the additive metal through the subsequent heat treatment and increase an amount of the oxide, when not all of the additive metals in the alloy powder were oxidized (when an oxidation rate was less than 100%) in the oxidation treatment in the high-energy ball mill. However, even when the additive metal is partially oxidized in the high-energy ball mill, the oxidation treatment by heating is not always necessary, because the alloy can reliably acquire strength as long as the required amount of dispersed particles is achieved. In addition, when the additional oxidation treatment is employed, it is preferable to set an oxygen pressure at a high pressure of about 7 to 9 atmospheres and heat the alloy powder in a range of a temperature of 700 to 900° C., because the dispersed particle may be coarsened by the additional oxidation treatment.

[0034] In addition, when the powder has been treated in a high-energy ball mill for a long period, the powder shows a phenomenon that oxygen dissolves into platinum, but then,

the excessive oxygen can be discharged by heat-treating the powder in an atmosphere with a reduced pressure and in a range of a temperature of 700 to 900° C.

[0035] An alloy powder which has been oxidized in the high-energy ball mill as was described above can be formed into a block alloy through compact solidification treatment. The compact solidification treatment is preferably carried out by such a method of sintering the alloy powder while pressurizing it, as in a hot press. It is preferable to set conditions in the hot press at a temperature of 700 to 1,300° C., and a press pressure of 10 MPa or higher. It is also preferable to set an atmosphere of the hot press to a vacuum atmosphere in order to prevent the oxidation of the alloy. In addition, it is preferable to preliminarily and tentatively sinter the alloy powder before compact solidification treatment.

[0036] An alloy after having been compacted and solidified can acquire an improved denseness by a forging process. The alloy also can be subjected to plastic working such as rolling, extruding and drawing to be formed into a predetermined shape, and heat treatment may be performed prior to these plastic workings. In a rolling step, a reduction ratio for a material is important in order to increase an aspect ratio of a structure, and thus can change the existence density of dispersed particles of an oxide in a rolling direction and a sheet thickness direction. Specifically, when the alloy is rolled, a distance between the dispersed particles of the oxide decreases in the sheet thickness direction of the material, whereas the distance increases in the rolling direction. In addition, when the material is subjected to heat treatment after having been rolled, it easily forms recrystallized grains having the shape which extends in the rolling direction through growth and has a high aspect ratio. The reduction ratio is preferably 70% or higher, and the higher is the reduction ratio, the higher aspect ratio acquires the obtained structure.

BRIEF DESCRIPTION OF THE DRAWINGS

[0037] FIG. 1 is an SEM image of a platinum-zirconia alloy powder produced by an atomization method in the first embodiment;

[0038] FIG. 2 is an SEM image of an alloy powder after having been treated in an attritor in the first embodiment;

[0039] FIG. 3 is an SEM image of a wire rod after having been treated for two hours in an attritor in the third embodiment;

[0040] FIG. 4 is an SEM image of a wire rod after having been treated for 30 hours in an attritor in the third embodiment; and

[0041] FIG. 5 is a photograph showing a condition of blow holes in a comparative example after having been welded.

BEST MODE FOR CARRYING OUT THE INVENTION

[0042] In the next place, a preferred embodiment according to the present invention is described. In the present embodiment, an oxide-dispersed platinum material was produced in which particles of zirconium oxide (zirconia) were dispersed in platinum.

[0043] First Embodiment: a platinum-zirconium alloy powder was produced by preparing a platinum—0.05 wt % zirconium alloy through vacuum melting, and gas-atomizing the molten metal of the alloy in argon atmosphere. As for conditions of atomization, an atomization temperature was

controlled to 2,000° C., and a gas pressure to 40 kPa. Thus obtained alloy powder had a particle diameter of 40 μm. FIG. 1 shows an SEM image of the alloy powder. As is clear from FIG. 1, the alloy powder produced here was an approximately spherical powder.

[0044] Subsequently, 1,500 g of an alloy powder was introduced into an attritor (with dimension: inside diameter of 200 mmφ×height of 185 mm, with material of zirconia, and consisting of vessel made from zirconia and zirconia-coated stainless stirring blade). In the above step, 7 kg of zirconia balls with a diameter of 5 mm and 1.0 L of ultrapure water were simultaneously introduced. Then, the attritor stirred the alloy powder at 340 rpm for 11 hours with a mixing impeller to oxidize the alloy powder. FIG. 2 shows a shape of the alloy powder after having been treated in the attritor. After a spherical alloy powder was treated in the attritor, it showed an indefinite shape by having been changed through the repetition of deformation and adhesion.

[0045] After having been oxidized, an alloy powder was taken out, was charged into a die, and was tentatively sintered by being heated in an atmosphere of 1.5×10^{-2} Pa at 1,200° C. for one hour. The sintered alloy had a dimension of 40 mm×40 mm×135 mm, a density of 7.42 g/cm³ and a denseness of 34.6%.

[0046] Then, tentatively-sintered alloy was compacted and solidified with a hot press. In the above step, a press temperature was set at 1,200° C. and a press pressure at 20 MPa. In addition, an atmosphere was controlled to be the vacuum atmosphere of 1.5×10^{-2} Pa, and a pressing period of time to be one hour. As a result of this, an obtained alloy compact had a dimension of 40.34 mm×40.45 mm×60.53 mm, a density of 16.23 g/cm³ and a denseness of 75.6%.

[0047] Then, a compact was hot-forged at a temperature of 1,300° C. in order to further have improved denseness. The forged alloy had a dimension of 65 mm×65 mm×18 mm, and acquired a denseness of about 100%. Finally, three sorts of sheet materials made from an oxide-dispersed platinum-zirconium alloy was obtained by the steps of: cold-rolling the alloy into a sheet thickness of 4 mm; heat-treating it (at 1,250° C.×30 min) to anneal it; and further cold-rolling it to the sheet thicknesses of 1.0 mm, 0.8 mm and 0.3 mm.

[0048] An amount of all oxygen in an oxide-dispersed platinum-zirconium alloy produced in the embodiment was firstly quantified with an oxygen analyzer. In addition, the amount of zirconia (amount of additive metal oxide) was quantified by melting a platinum material in aqua regia, separating a residue by filtration, and weighing the residue. As a result of having calculated the concentration of excessive oxygen and an oxidation rate of a platinum material according to the present embodiment from the above measured values, the concentration of excessive oxygen was 0 ppm, and the oxidation rate was 50%. In addition, a particle diameter and a dispersion state of dispersed particles in the produced alloy were confirmed by immersing the produced alloy in aqua regia (at 80° C.) to dissolve platinum, and observing the dispersed particles. As a result, the particle diameter of the zirconia particles in the platinum alloy according to the present embodiment was estimated to be 0.02 μm. In addition, as a result of having calculated an average value of distances between particles based on a regular tetrahedron model (which supposes that dispersed particles are placed on the vertices of a regular tetrahedron), it was estimated to be 0.19 μm.

[0049] Second Embodiment: a platinum material was prepared by the steps of: preparing a platinum alloy powder through attritor treatment as in the case of the first embodiment; further oxidizing the platinum alloy powder in an oxidizing pot; and compacting and solidifying the powder in the same conditions as in the first embodiment. In the above step, the oxidation treatment condition was set at an oxygen pressure of 9 atmospheres, a temperature of 800° C. and a heating period of time of 10 hours.

[0050] As a result of having calculated an oxidation rate and the concentration of excessive oxygen in an oxide-dispersed platinum-zirconium alloy produced according to the present embodiment as in the case of the first embodiment, the concentration of excessive oxygen was 95 ppm, and the oxidation rate was 100%. In addition, as a result of having confirmed a particle diameter and a dispersion state of dispersed particles in the produced alloy as in the case of the first embodiment, the diameter of the zirconia particle was estimated to be 0.02 μm , and an average value of distances between the particles to be 0.34 μm .

[0051] Third Embodiment: a cut wire rod was prepared by the steps of: preparing a molten metal of a platinum alloy by vacuum-melting the alloy as in the case of the first embodiment; casting the molten metal to obtain an ingot; wire-drawing the ingot into a wire rod with a diameter of 0.1 mm; and then cutting it into the length of 3 mm. Then, the cut wire rod was treated in an attritor at 340 rpm for 30 hours. FIG. 3 shows a state of a powder after 2 hours of attritor treatment, and FIG. 4 shows a state of the powder after 30 hours. The above treated powder was heat-treated in an atmosphere of 800° C. with a reduced pressure of 1.5×10^{-2} Pa, for 10 hours. Then, the powder was compacted and solidified into a platinum material in the same conditions as in the first embodiment.

[0052] As a result of having calculated an oxidation rate and the concentration of excessive oxygen of an oxide-dispersed platinum-zirconium alloy produced according to the present embodiment as in the case of the first embodiment, the concentration of excessive oxygen was 60 ppm, and the oxidation rate was 100%. In addition, as a result of having confirmed a particle diameter and a dispersed state of dispersed particles in the produced alloy as in the case of the first embodiment, the diameter of the zirconia particle was estimated to be 0.02 μm , and an average value of distances between particles to be 0.34 μm .

[0053] Comparative Example: here, a platinum material was prepared so as to contain a higher concentration of excessive oxygen than that of the above described first to third embodiments. The platinum material was prepared by the steps of: preparing a platinum alloy powder through attritor treatment as in the case of the first embodiment; further oxidizing the platinum alloy powder in an oxidizing pot; and compacting and solidifying the powder in the same conditions as in the first embodiment. In the above step, the oxidation treatment condition was set at an oxygen pressure of 9 atmospheres, a temperature of 800° C. and a heating period of time of 15 hours. As a result of having calculated an oxidation rate and the concentration of excessive oxygen of an oxide-dispersed platinum-zirconium alloy produced in the present comparative example as in the case of the first embodiment, the concentration of excessive oxygen was 115 ppm, and the oxidation rate was 100%.

[0054] A platinum material produced in each embodiment and comparative example described above was subjected to a

creep rupture test, and further to the examinations for confirming whether a blow hole was produced or not when the material was welded, and whether a blister was produced or not when the material was heated at a high temperature. The creep rupture strength was determined by measuring a period of time before the sheet with the thickness of 0.8 mm is ruptured after having had been placed in an atmosphere of 1,400° C. with the applied stress of 20 MPa. In the welding test, the surface of the sheet with the thickness of 1.0 mm was swept with an automatic welding machine, and the presence or absence of the blow hole in a melted zone was visually observed. In addition, in a heating test, the sheet with the thickness of 0.3 mm was heated to 1,700° C. and held for 3 hours, and then it was examined by visual observation whether a blister occurred on the surface or not. These examination results are shown in the following table.

TABLE 1

	Concentration of excessive oxygen	Oxi- dation rate of Zr	Creep rupture time	Presence or absence of blow hole	Presence or absence of blister
First Embodiment	0 ppm	50%	208 hr	None	None
Second Embodiment	95 ppm	100%	352 hr	None	None
Third Embodiment	60 ppm	100%	251 hr	None	None
Comparative Example	115 ppm	100%	364 hr	A few	A few

[0055] It is clear from Table 1 that all the platinum materials produced in the present embodiment exceeded 200 hours in the creep rupture time. As for the creep rupture time, platinum shows the creep strength of 1.7 MPa by breaking force when tested at 1,400° C. for 100 hours, and is immediately broken when the force is 20 MPa. In addition, even currently commercially-available, conventional strengthened platinum shows the creep rupture time of about 100 hours when tested at 1,400° C. and 20 MPa. Accordingly, it is clear that the platinum materials according to the present embodiments are sufficiently strengthened.

[0056] In addition, the platinum materials according to the present embodiments showed adequate appearance without forming a blow hole after having been welded and a blister after having been heated to a high temperature. On the other hand, the platinum material according to the comparative example showed the blow hole and the blister though a few. FIG. 5 shows a state of the blow hole formed when the comparative example was welded. Such a blow hole and a blister grow into a void while the material is used at a high temperature for a long period, and cause the reduction of material strength.

INDUSTRIAL APPLICABILITY

[0057] As described above, an oxide-dispersed platinum material according to the present invention does not cause such a phenomenon of affecting material strength as the formation of a blister, even when having been used for a long period under a high-temperature environment, and can be stably used. In addition, the platinum material has adequate weldability, and can provide a wholesome weld which does not show a weld defect such as a blow hole.

1. An oxide-dispersion-strengthened platinum material which comprises dispersed particles made from a metallic oxide of an additive metal are dispersed in a matrix made from platinum or a platinum alloy, wherein a concentration of oxygen in the material except oxygen bound to the additive metal is 100 ppm or lower.

2. The oxide-dispersion-strengthened platinum material according to claim 1, wherein an average diameter of the dispersed particles is 0.2 μm or smaller, an average value of distances between the particles is 0.01 to 2.7 μm , and the concentration of the dispersed particles in the matrix is 0.01 to 0.5 wt %.

3. The oxide-dispersion-strengthened platinum material according to claim 1, wherein the oxidation rate of the additive metal is 50 to 100%.

4. The oxide-dispersion-strengthened platinum material according to claim 1, wherein the additive metal is any of zirconium, calcium, yttrium and samarium.

5. The oxide-dispersion-strengthened platinum material according to claim 1, wherein the matrix is any of a platinum-rhodium alloy, a platinum-gold alloy, a platinum-rhodium-gold alloy and a platinum-iridium alloy.

6. The oxide-dispersion-strengthened platinum material according to claim 2, wherein the oxidation rate of the additive metal is 50 to 100%.

7. The oxide-dispersion-strengthened platinum material according to claim 2, wherein the additive metal is any of zirconium, calcium, yttrium and samarium.

8. The oxide-dispersion-strengthened platinum material according to claim 3, wherein the additive metal is any of zirconium, calcium, yttrium and samarium.

9. The oxide-dispersion-strengthened platinum material according to claim 6, wherein the additive metal is any of zirconium, calcium, yttrium and samarium.

10. The oxide-dispersion-strengthened platinum material according to claim 2, wherein the matrix is any of a platinum-

rhodium alloy, a platinum-gold alloy, a platinum-rhodium-gold alloy and a platinum-iridium alloy.

11. The oxide-dispersion-strengthened platinum material according to claim 3, wherein the matrix is any of a platinum-rhodium alloy, a platinum-gold alloy, a platinum-rhodium-gold alloy and a platinum-iridium alloy.

12. The oxide-dispersion-strengthened platinum material according to claim 4, wherein the matrix is any of a platinum-rhodium alloy, a platinum-gold alloy, a platinum-rhodium-gold alloy and a platinum-iridium alloy.

13. The oxide-dispersion-strengthened platinum material according to claim 6, wherein the matrix is any of a platinum-rhodium alloy, a platinum-gold alloy, a platinum-rhodium-gold alloy and a platinum-iridium alloy.

14. The oxide-dispersion-strengthened platinum material according to claim 7, wherein the matrix is any of a platinum-rhodium alloy, a platinum-gold alloy, a platinum-rhodium-gold alloy and a platinum-iridium alloy.

15. The oxide-dispersion-strengthened platinum material according to claim 8, wherein the matrix is any of a platinum-rhodium alloy, a platinum-gold alloy, a platinum-rhodium-gold alloy and a platinum-iridium alloy.

16. The oxide-dispersion-strengthened platinum material according to claim 9, wherein the matrix is any of a platinum-rhodium alloy, a platinum-gold alloy, a platinum-rhodium-gold alloy and a platinum-iridium alloy.

17. The oxide-dispersion-strengthened platinum material according to claim 1 wherein an average diameter of the dispersed particles is 0.2 μm or smaller, an average value of distances between the particles is 0.01 to 2.7 μm , the concentration of the dispersed particles in the matrix is 0.01 to 0.5 wt %; wherein the oxidation rate of the additive metal is 50 to 100%; wherein the additive metal is any of zirconium, calcium, yttrium and samarium; and wherein the matrix is any of a platinum-rhodium alloy, a platinum-gold alloy, a platinum-rhodium-gold alloy and a platinum-iridium alloy.

* * * * *