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

(11) EP 2 781 628 A1

(12) # EUROPEAN PATENT APPLICATION

published in accordance with Art. 153(4) EPC

(43) Date of publication:
24.09.2014 Bulletin 2014/39

(21) Application number: **11875931.5**

(22) Date of filing: **15.11.2011**

(51) Int Cl.:
C25D 1/10 ^(2006.01) ***B29C 33/38*** ^(2006.01)

(86) International application number:
PCT/JP2011/006355

(87) International publication number:
WO 2013/072953 (23.05.2013 Gazette 2013/21)

(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

(71) Applicant: **Leap Co. Ltd.**
Kanagawa 224-0032 (JP)

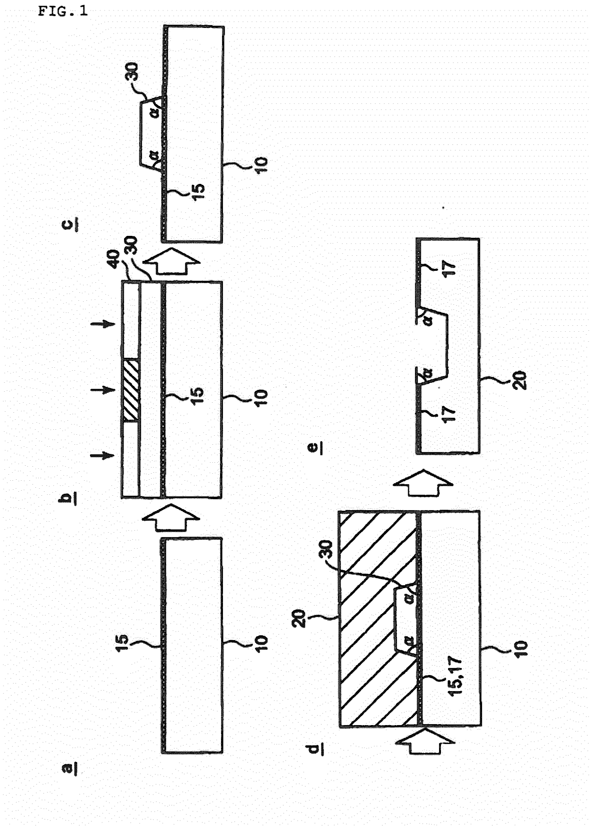
(72) Inventors:
- **SANO, Takashi**
  Yokohama-shi
  Kanagawa 224-0032 (JP)
- **TERADA, Tokinori**
  Yokohama-shi
  Kanagawa 224-0032 (JP)

(74) Representative: **Becker Kurig Straus**
Patentanwälte
Bavariastrasse 7
80336 München (DE)

(54) **PRODUCTION METHOD FOR TRANSFER MOLD, TRANSFER MOLD PRODUCED USING SAME, AND COMPONENT PRODUCED USING SAID TRANSFER MOLD**

(57) A transfer mold, which has superior durability and high aspect ratio, for production of a component by electroplating and a component produced thereby are provided. A method therefor includes the steps of: forming a resist pattern having a shape of a component with a desired aspect ratio on a metal substrate 10, a sidewall of the resist pattern forming a desired angle α; creating a transfer mold by filing up the resist pattern having the shape of the component by electroplating to a predetermined thickness; and providing a master mold 20 by separating the transfer mold from the metal substrate.

FIG. 1



EP 2 781 628 A1

Description

Technical Field

[0001] The present invention relates to a transfer mold manufacturing method, a transfer mold manufactured thereby, and a component produced by the transfer mold. More specifically, the present invention relates to a method for manufacturing a transfer mold for production of a component by electroplating, a transfer mold manufactured thereby, and a component produced thereby, wherein the transfer mold has superior durability and high aspect ratio.

Background Art

[0002] Electroplating allows formation of a thick film conductor with less restriction in terms of dimension. It is therefore widely used in production of display components such as a dial and hands of a watch, machine components such as a small gear, a spring, a pipe and a diaphragm (pressure sensor) and electronic components such as a wiring of a semiconductor device and a coil.

[0003] Patent Document 1 discloses manufacturing a cavity insert by: first creating a machined master mold on which a fine pattern has been formed in advance; subsequently creating a transfer master mold by hot press from the machined master mold; and then creating the cavity insert by electroplating from the transfer master mold.

[0004] Patent Document 2 discloses manufacturing a watch dial by the steps of: forming a mask pattern having openings on a surface of a silicon wafer; performing an anisotropic etching; forming a common electrode film; forming an electroplated film which grows on the common electrode film; etching the silicon wafer; and forming a resin watch dial having protruding portions by using the electroplated film as a transfer mask.

[0005] Fig. 6 shows structural drawings of a component formed by using a conventional transfer mold. In Fig. 6a, for the purpose of forming a component 95, a photoresist 30 is patterned on a metal substrate 90 to a shape of the component by partially removing the same. The metal substrate 90, on which the resist pattern has thus been formed, is used as a transfer mold for electroplating (hereinafter referred to as "EP") a predetermined metal (Ag, Cu, Ni, etc.) to form the component 95.

[0006] In Fig. 6b, the component 95 molded by EP is transferred onto an adhesive bond 85 and then adhered to a component substrate 97. In this manner, the component having a given shape depending on its intended use is produced by EP and transferred onto the component substrate 97 for use.

[0007] Here, for ease of release and transfer of the component 95, the angles β formed at sidewalls of the photoresist 30 are each set to be a blunt angle of less than 45°. In the meantime, when providing an electronic component such as a wiring, a coil, etc. on a semiconductor substrate, there is a demand for such an aspect ratio that a line thickness is greater than the line width so that electric resistance is reduced. The thickness which the photoresist 30 is generally required to have is approximately 10 μm.

[0008] The component 95 is formed by EP in such a manner that it fills up along the sidewalls of the photoresist 30 having the thickness of approximately 10 μm. As such, in a case where a wiring pattern, a conductive coil or the like is formed as a long component, it contacts the sidewalls in large area, resulting in increased release resistance in the release and transfer of the component. That is, when using a transfer mold made with patterned photoresist, the transfer of the component onto the component substrate 97 requires an application of a release force that is comparable to the increased release resistance. This causes the edge of the pattern of the photoresist 30, which is appressed to the metal substrate 90, to be easily stripped. In fact, the resist is stripped after a few times of use, and as a result, a problem arises that the transfer mold can then no longer be in use.

Citation List

Patent Documents

[0009]

Patent Document 1: Japanese Patent Application Laid-Open No. 2004-1535

Patent Document 2: Japanese Patent Application Laid-Open No. 2004-257861

Summary of the Invention

Problems to be solved by the Invention

[0010] The present invention has been made in order to solve the above problem, and its purpose is to provide a transfer mold having superior durability and high aspect ratio for production of a component by EP as well as to provide a component produced by the transfer mold. It is to be noted that there are four types of transfer molds which are: a master mold, a mother mold, a son mold, and a transfer mold. The master mold is a mold which serves as a prototype for component production. Usually, it is not directly used for component production. The mother mold is a mold which is created by using the master mold so as to have an inverse contour of the master mold. The mother mold as well is not directly used for the component production. The son mold is a mold which is created by using the mother mold so as to have an inverse contour of the mother mold. Therefore, the son mold has a shape that is identical with the master mold. The transfer mold is generally formed by subjecting the son mold to an insulation layer formation process, a releasing layer formation process, etc. The component production is then carried out with use of this transfer mold, and when it is worn off, a new transfer mold is created again from the master mold by way of the mother mold and the son mold.

Means for solving the Problems

[0011] A transfer mold manufacturing method of the present invention includes steps of: forming a resist pattern having a shape of a component with a desired aspect ratio on a metal substrate, a sidewall of the resist pattern forming a desired angle α; creating a transfer mold by filling up the resist pattern having the shape of the component by electroplating to a predetermined thickness; and providing a master mold by separating the transfer mold from the metal substrate leaving the metal substrate and the resist pattern.

[0012] A transfer mold manufacturing method of the present invention includes steps of: forming a resist pattern having a shape of a component with a desired aspect ratio on a metal substrate, a sidewall of the resist pattern forming a desired angle α; creating a transfer mold by filling up the resist pattern having the shape of the component by electroplating to a predetermined thickness; providing a master mold by separating the transfer mold from the metal substrate leaving the metal substrate and the resist pattern; creating a son mold by transferring by way of the master mold and a mother mold; and providing a transfer mold by performing, on the son mold, a releasing layer formation process for facilitating a release of the component to be formed by electroplating and an insulation layer formation process for forming an insulation layer in that portion which is other than a portion in which the component is to be formed.

[0013] The transfer mold manufacturing method of the present invention includes a step of forming a roughening layer on a surface of the metal substrate as a first step.

[0014] A transfer mold manufacturing method of the present invention includes steps of: forming a resist pattern having a shape of a component with a desired aspect ratio on a metal substrate, a sidewall of the resist pattern forming an angle of approximately 90°; creating a transfer mold by filling up the resist pattern having the shape of the component by electroplating to a predetermined thickness; separating the transfer mold from the metal substrate; removing a photoresist partially to leave a resist pattern layer in that portion of the separated transfer mold which is other than a portion corresponding to the component to be transferred; and providing a master mold by treating the sidewall of the shape of the component with beam irradiation using the resist pattern layer as a protective layer, the beam irradiation being modulated such that the angle at the sidewall is tailored to form approximately 90° or a given angle less than 90°

[0015] A transfer mold manufacturing method of the invention of the instant application includes steps of: forming a resist pattern having a shape of a component with a desired aspect ratio on a metal substrate, a sidewall of the resist pattern forming an angle of approximately 90°; creating a transfer mold by filling up the resist pattern having the shape of the component by electroplating to a predetermined thickness; separating the transfer mold from the metal substrate; removing a photoresist partially to leave a resist pattern layer in that portion of the separated transfer mold which is other than a portion corresponding to the component to be transferred; providing a master mold by treating the sidewall of the shape of the component with beam irradiation using the resist pattern layer as a protective layer, the beam irradiation being modulated such that the angle at the sidewall is tailored to form approximately 90° or a given angle less than 90°; creating a son mold by transferring by way of the master mold and a mother mold; and providing a transfer mold by performing, on the son mold, a releasing layer formation process for facilitating a release of the component to be formed by electroplating and an insulation layer formation process for forming an insulation layer in that portion which is other than a portion in which the component is to be formed.

[0016] The method of the present invention includes a step of forming a roughening layer on a surface of the metal substrate as a first step.

[0017] A master mold of the present invention is manufactured by the above-described method and has a cross-sectional surface with a desired aspect ratio, a sidewall of the cross-sectional surface forming an angle between 45° and 88°.

[0018] A transfer mold of the present invention is provided by subjecting the son mold created by using the above-described master mold to only an insulation layer formation process or to the insulation layer formation process and a releasing layer formation process.

[0019] A component produced by electroplating in the present invention is molded by the electroplating using the above-described transfer mold and transferred.

[0020] Advantageous Effect of the Invention

[0021] The present invention makes it possible to provide a component having superior durability and high aspect ratio formed by EP in manufacturing display components, machine components and electronic components by EP.

Brief Description of the Drawings

[0022]

Fig. 1 is a process drawing showing the steps for manufacturing a master mold by electroplating according to the present invention.

Fig. 2 is a process drawing showing the steps for manufacturing a master mold by beam treatment according to the present invention.

Fig. 3 is a process drawing showing the steps for manufacturing a son mold according to the present invention.

Fig. 4 is a process drawing showing the steps for manufacturing a transfer mold according to the present invention.

Fig. 5 is a process drawing showing the steps for manufacturing a component according to the present invention.

Fig. 6 is a structural drawing showing a component formed by using a conventional transfer mold.

Mode for carrying out the Invention

Embodiments

[0023] A first embodiment of the present invention is described with reference to the drawings. Fig. 1 is a process drawing showing the steps for manufacturing a master mold by electroplating according to the present invention. In Fig. 1a, a top surface of a metal substrate 10 is provided with a roughening layer 15 for roughening a contact surface of a master mold to be formed by EP. The roughening layer 15 may be formed by roughening the surface of the metal substrate 10 directly by hydrochloric acid treatment or the like. Alternatively, a stripe-like photo resist pattern layer, a lattice-like photo resist pattern layer or the like, which is suitable for roughening, may be formed as the roughening layer 15 by partially removing the photoresist. In a case where an insulation layer and others are formed on a son mold 60 described later with reference to Fig. 3, the roughening layer 15 may be omitted as long as there is no problem of adhesion strength therebetween.

[0024] In Fig. 1b, a photoresist 30 for forming a pattern of a shape of a component to be produced is applied onto the roughening layer 15 on the metal substrate 10 to a predetermined thickness. This is for the purpose of obtaining a component having such a shape that has a desired aspect ratio and desired angles α at sidewalls thereof. For example, in a case where a wiring of a semiconductor electronic component or a coil with a line width of 5 μm is to be produced, the photoresist 30 is applied to a thickness of 10 μm so that the electronic component or the coil has the thickness of 10 μm. The photoresist 30 is then subjected to an exposure effected from the direction of the arrows with an intervening photomask 40 having a pattern of a desired component. Fig. 1c shows the pattern of the component formed by subjecting the resist pattern to the exposure as shown in Fig. 1b and a development. The angles α formed at the respective sidewalls of the resist pattern of the component can optionally be determined depending on the material and film thickness of the applied photoresist 30 as well as the exposure condition to the irradiation performed with the intervening photomask 40 as shown in Fig. 1b. Where laser light is used, a 3D lens may be employed to vary the irradiation intensity on the both sidewalls of the resist pattern. The irradiation intensity on the both sidewalls may also be varied by means of a gray mask.

[0025] In Fig. 1d, a desired metal, e.g., Ni, is electroplated to a predetermined thickness so as to cover the resist pattern 30 shown in Fig. 1c, thereby creating a master mold 20. In Fig. 1e, the master mold 20 created by EP in Fig. 1d is separated from the metal substrate 10. Here, the rough surface profile of the roughening layer 15 has been transferred to a roughened surface layer 17 of the master mold. The angles α at the both sidewalls remain to be the angles α in Fig. 1d.

[0026] It is intended that the roughened surface layer 17 of the master mold is transferred to the son mold 60, which is eventually used as the transfer mold and illustrated in Fig. 3, for the sake of increased adhesion strength to an insulation layer to be formed thereon. As such, it is not necessarily required. In addition, making the angles α as acute as 45° to 88° allows the pattern density of an intended device to be improved. The 10 μm thickness of the photoresist 30 in Fig. 1c is maintained in the inverted master mold 20 by being transferred.

[0027] Fig. 2 is a process drawing showing the steps for manufacturing a master mold by beam treatment according to the present invention. This is a second embodiment of the present invention. Fig. 2a shows the master mold 20 created by the method illustrated in Fig. 1. Here, the angles α are each approximately 90°. In Fig. 2b, the photoresist 30 for forming a reverse pattern of the shape of the component is applied to a predetermined thickness. The photoresist 30 is then subjected to an exposure effected from the direction of the arrows with an intervening photomask 40 having the reverse pattern of the component. As a result, that portion of the resist which corresponds to the component is developed and removed, thereby leaving the photoresist 30 only on the flat roughened surface layer 17 of the master mold.

[0028] In Fig. 2c, the resist pattern formed in Fig. 2b is used as a protective film in treating the sidewalls of the pattern of the component with beam irradiation. Here, the irradiation beam is modulated in such a manner that the angles α are tailored to form predetermined degrees. The arrows show the direction of the beam. The treated master mold 20 shown in Fig. 2d has not only the same shape but also the same function and characteristics as the master mold 20 shown in Fig. 1d. The irradiation beam may be an electron beam, an ion beam, or a FIB (Focused Ion Beam) whose irradiation strength is variable by focusing the beam with a lens.

[0029] Fig. 3 is a process drawing showing the steps for manufacturing a son mold according to the present invention. In Fig. 3a, a desired metal, e.g., Ni, is electroplated to a predetermined thickness on that surface of the master mold 20 manufactured in Fig. 1 or 2 on which the pattern of the component has been formed. A mother mold 50 created thereby is then separated. In Fig. 3b, a desired metal, e.g., Ni, is electroplated to a predetermined thickness on that surface of the mother mold 50 on which the pattern of the component has been formed, so that a son mold 60 is created in the same manner. In Fig. 3c, the son mold 60 thus created by EP is separated from the mother mold 50.

[0030] In this way, the son mold 60 is created by transferring the mother mold 50 created by transferring the master mold 20. As such, it takes over the same function and characteristics as those of the master mold 20. Furthermore, the son mold 60 is integrally formed of one metal material. This, with the releasing layer formation process and the insulation layer formation process performed on a roughened surface layer 19 of the son mold as will be explained next, makes it possible to obtain a transfer mold which has a desired aspect ratio and angles α, does not break even after repetitive use, and is highly suitable for quantity production.

[0031] Fig. 4 is a process drawing showing the steps for manufacturing a transfer mold according to the present invention. Fig. 4a shows the son mold 60 created in Fig. 3c. In Fig. 4b, the son mold 60 is subjected to heat treatment under prescribed conditions for ease of release and transfer of the component to be produced. This is followed by the releasing layer formation process for forming a NiOx film 70 having a predetermined thickness on the surface of the son mold 60. Since the NiOx film 70 is conductive, it does not hinder EP. Moreover, the low adhesive property thereof to the electroplated component allows an easy release.

[0032] Subsequently, an insulation layer is formed in order to prevent EP in that portion of the surface which is other than the portion in which the component is to be formed. This is accomplished by the insulation layer formation process for forming a SiO_2 film 80 chemically by CVD (Chemical Vapor Deposition) or physically by sputtering on said portion of the surface. Alternatively, the SiO_2 film 80 is formed by applying polysilazane and treating it with heat. In Fig. 4c, in order to remove the SiO_2 film 80 formed on the pattern of the component, the photoresist 30 to be patterned to a predetermined shape is applied on the SiO_2 film 80. After that, the photoresist is partially removed by subjecting the same to an exposure effected from the direction of the arrows with an intervening photomask 40 having the reverse pattern of the component. Then, in Fig. 4d, with use of the patterned photoresist 30 as a mask, the SiO_2 film 80 is removed physically by beam irradiation from the direction of the arrows or chemically by hydrofluoric acid treatment or the like.

[0033] Depending on the shape of the patterned photoresist 30 and the removal conditions of the SiO_2 film 80, the transfer mold is completed either by removing the SiO_2 film 80 only in the bottom portion so that it is left on the sidewalls as shown in Fig. 4e or by removing the SiO_2 film 80 both on the sidewalls and in the bottom portion as shown in Fig. 4f. In a case where polysilazane is used, similar steps as in screen printing are carried out. That is, following the formation of the NiOx film 70 in Fig. 4b, polysilazane is printed in that portion of the surface of the NiOx film 70 which is other than the pattern of the component for forming the component. It is then treated with heat. In this manner, the same shape as shown in Fig. 4f can be obtained.

[0034] The releasing layer formation process is performed by, as shown in Fig. 4b, depositing metal oxides (AlOx, TiOx, etc.), nitrides or organic substances (resist) on the son mold 60 to such a thickness of 1 to 1000 Å that allows the conductivity thereof to be maintained. For the insulation layer formation process, an insulator such as resist may be used instead of SiO_2. Note that the releasing layer formation process and the insulation layer formation process may be performed in reverse order.

[0035] Now, description is made for the component produced by EP with use of the transfer mold according to the present invention. Fig. 5 is a process drawing showing the steps for manufacturing a component using the transfer mold according to the present invention. In Fig. 5a, a desired metal (Ag, Cu, Ni, etc.) is electroplated on the transfer mold 60 to form the component 95. In Fig. 5b, the component 95 molded by EP is, as in the case shown in Fig. 6b, transferred onto the adhesive bond 85 and then adhered to the component substrate 97. Alternatively, the component 95 is adhered to a green sheet 98 which is then treated with heat for curing. Where the component 95 is adhered to the green sheet 98, the use of the adhesive bond 85 is eliminated by such softness of the green sheet 98 before curing that the component 95 is buried therein. In this way, the component 95 of an optional shape having a desired aspect ratio and angles α is provided by EP. It can be repetitively molded and transferred onto the device substrate 97 or green sheet 98 for diverse intended use.

[0036] As described above, the present invention is able to provide a component having superior durability and high aspect ratio in production, by EP, of display components such as a dial and hands of a watch, machine components such as a small gear, a spring, a pipe and a diaphragm (pressure sensor), and electronic components such as a wiring of a semiconductor device and a coil.

Description of Reference Numerals

[0037]

10 metal substrate
15 master mold roughening layer
17 roughened surface layer of master mold
18 roughened surface layer of mother mold
19 roughened surface layer of son mold
20 master mold
30 photoresist
40 photomask
50 mother mold
60 son mold
70 NiOx
75 release treatment layer
80 SiO_2/polysilazane
85 adhesive bond
90 metal substrate
95 component
97 component substrate
98 green sheet
α angle at sidewall

β angle at sidewall

Claims

1. A transfer mold manufacturing method comprising steps of:

   forming a resist pattern having a shape of a component with a desired aspect ratio on a metal substrate, a sidewall of the resist pattern forming a desired angle α;
   creating a transfer mold by filling up the resist pattern having the shape of the component by electroplating to a predetermined thickness; and
   providing a master mold by separating the transfer mold from the metal substrate.

2. A transfer mold manufacturing method comprising steps of:

   forming a resist pattern having a shape of a component with a desired aspect ratio on a metal substrate, a sidewall of the resist pattern forming a desired angle α;
   creating a transfer mold by filling up the resist pattern having the shape of the component by electroplating to a predetermined thickness;
   providing a master mold by separating the transfer mold from the metal substrate ;
   creating a son mold by transferring by way of the master mold and a mother mold; and
   providing a transfer mold by performing, on the son mold, a releasing layer formation process for facilitating a release of the component to be formed by electroplating and an insulation layer formation process for forming an insulation layer in that portion which is other than a portion in which the component is to be formed.

3. The method according to claim 1 or 2, comprising a step of forming a roughening layer on a surface of the metal substrate as a first step.

4. A transfer mold manufacturing method comprising steps of:

   forming a resist pattern having a shape of a component with a desired aspect ratio on a metal substrate, a sidewall of the resist pattern forming an angle of approximately 90°;
   creating a transfer mold by filling up the resist pattern having the shape of the component by electroplating to a predetermined thickness;
   separating the transfer mold from the metal substrate;
   removing a photoresist partially to leave a resist pattern layer in that portion on the separated transfer mold which is other than a portion corresponding to the component to be transferred; and
   providing a master mold by treating the sidewall of the shape of the component with beam irradiation using the resist pattern layer as a protective layer, the beam irradiation being modulated such that the angle at the sidewall is tailored to form approximately 90° or a given angle less than 90°

5. A transfer mold manufacturing method comprising steps of:

   forming a resist pattern having a shape of a component with a desired aspect ratio on a metal substrate, a sidewall of the resist pattern forming an angle of approximately 90°;
   creating a transfer mold by filling up the resist pattern having the shape of the component by electroplating to a predetermined thickness;
   separating the transfer mold from the metal substrate;
   removing a photoresist partially to leave a resist pattern layer in that portion on the separated transfer mold which is other than a portion corresponding to the component to be transferred;
   providing a master mold by treating the sidewall of the shape of the component with beam irradiation using the resist pattern layer as a protective layer, the beam irradiation being modulated such that the angle at the sidewall is tailored to form approximately 90° or a given angle less than 90°;
   creating a son mold by transferring by way of the master mold and a mother mold; and
   providing a transfer mold by performing, on the son mold, a releasing layer formation process for facilitating a release of the component to be formed by electroplating and an insulation layer formation process for forming an insulation layer in that portion which is other than a portion in which the component is to be formed.

6. The method according to claim 4 or 5, comprising a step of forming a roughening layer on a surface of the metal substrate as a first step.

7. A master mold manufactured by the method according to any one of claims 1, 3, 4 and 6 having a cross-sectional surface with a desired aspect ratio, a sidewall of the cross-sectional surface forming an angle between 45° and 88°.

8. A transfer mold manufactured by the method according to any one of claims 2, 3, 5 and 6.

9. A component produced by electroplating, the com-

ponent being molded by the electroplating using the transfer mold according to claim 8 and transferred.

Amended claims under Art. 19.1 PCT

1. A transfer mold manufacturing method comprising steps of:

forming a resist pattern having a shape of a component with a desired aspect ratio on a metal substrate, a sidewall of the resist pattern forming a desired angle α;
creating a transfer mold by filling up the resist pattern having the shape of the component by electroplating to a predetermined thickness; and
providing a master mold by separating the transfer mold from the metal substrate leaving the metal substrate and the resist pattern.

2. A transfer mold manufacturing method comprising steps of:

forming a resist pattern having a shape of a component with a desired aspect ratio on a metal substrate, a sidewall of the resist pattern forming a desired angle α;
creating a transfer mold by filling up the resist pattern having the shape of the component by electroplating to a predetermined thickness;
providing a master mold by separating the transfer mold from the metal substrate leaving the metal substrate and the resist pattern;
creating a son mold by transferring by way of the master mold and a mother mold; and
providing a transfer mold by performing, on the son mold, a releasing layer formation process for facilitating a release of the component to be formed by electroplating and an insulation layer formation process for forming an insulation layer in that portion which is other than a portion in which the component is to be formed.

3. The method according to claim 1 or 2, comprising a step of forming a roughening layer on a surface of the metal substrate as a first step.

4. A transfer mold manufacturing method comprising steps of:

forming a resist pattern having a shape of a component with a desired aspect ratio on a metal substrate, a sidewall of the resist pattern forming an angle of approximately 90°;
creating a transfer mold by filling up the resist pattern having the shape of the component by electroplating to a predetermined thickness;
separating the transfer mold from the metal substrate;
removing a photoresist partially to leave a resist pattern layer in that portion on the separated transfer mold which is other than a portion corresponding to the component to be transferred; and
providing a master mold by treating the sidewall of the shape of the component with beam irradiation using the resist pattern layer as a protective layer, the beam irradiation being modulated such that the angle at the sidewall is tailored to form approximately 90° or a given angle less than 90°

5. A transfer mold manufacturing method comprising steps of:

forming a resist pattern having a shape of a component with a desired aspect ratio on a metal substrate, a sidewall of the resist pattern forming an angle of approximately 90°;
creating a transfer mold by filling up the resist pattern having the shape of the component by electroplating to a predetermined thickness;
separating the transfer mold from the metal substrate;
removing a photoresist partially to leave a resist pattern layer in that portion on the separated transfer mold which is other than a portion corresponding to the component to be transferred;
providing a master mold by treating the sidewall of the shape of the component with beam irradiation using the resist pattern layer as a protective layer, the beam irradiation being modulated such that the angle at the sidewall is tailored to form approximately 90° or a given angle less than 90°;
creating a son mold by transferring by way of the master mold and a mother mold; and
providing a transfer mold by performing, on the son mold, a releasing layer formation process for facilitating a release of the component to be formed by electroplating and an insulation layer formation process for forming an insulation layer in that portion which is other than a portion in which the component is to be formed.

6. The method according to claim 4 or 5, comprising a step of forming a roughening layer on a surface of the metal substrate as a first step.

7. A master mold manufactured by the method according to any one of claims 1, 3, 4 and 6 having a cross-sectional surface with a desired aspect ratio, a sidewall of the cross-sectional surface forming an angle between 45° and 88°.

8. A transfer mold manufactured by the method according to any one of claims 2, 3, 5 and 6.

9. A component produced by electroplating, the component being molded by the electroplating using the transfer mold according to claim 8 and transferred.

FIG. 1

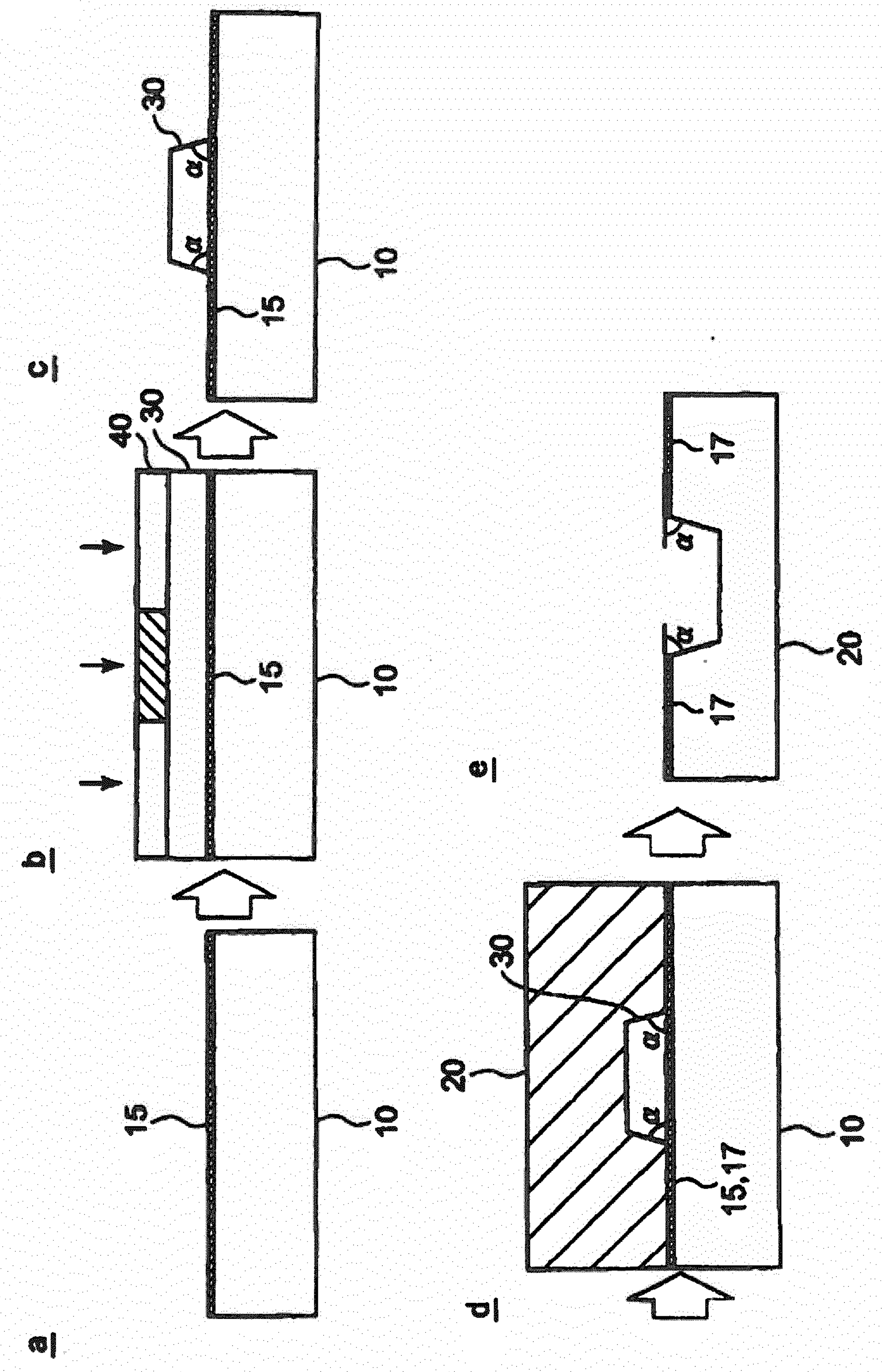


FIG.2

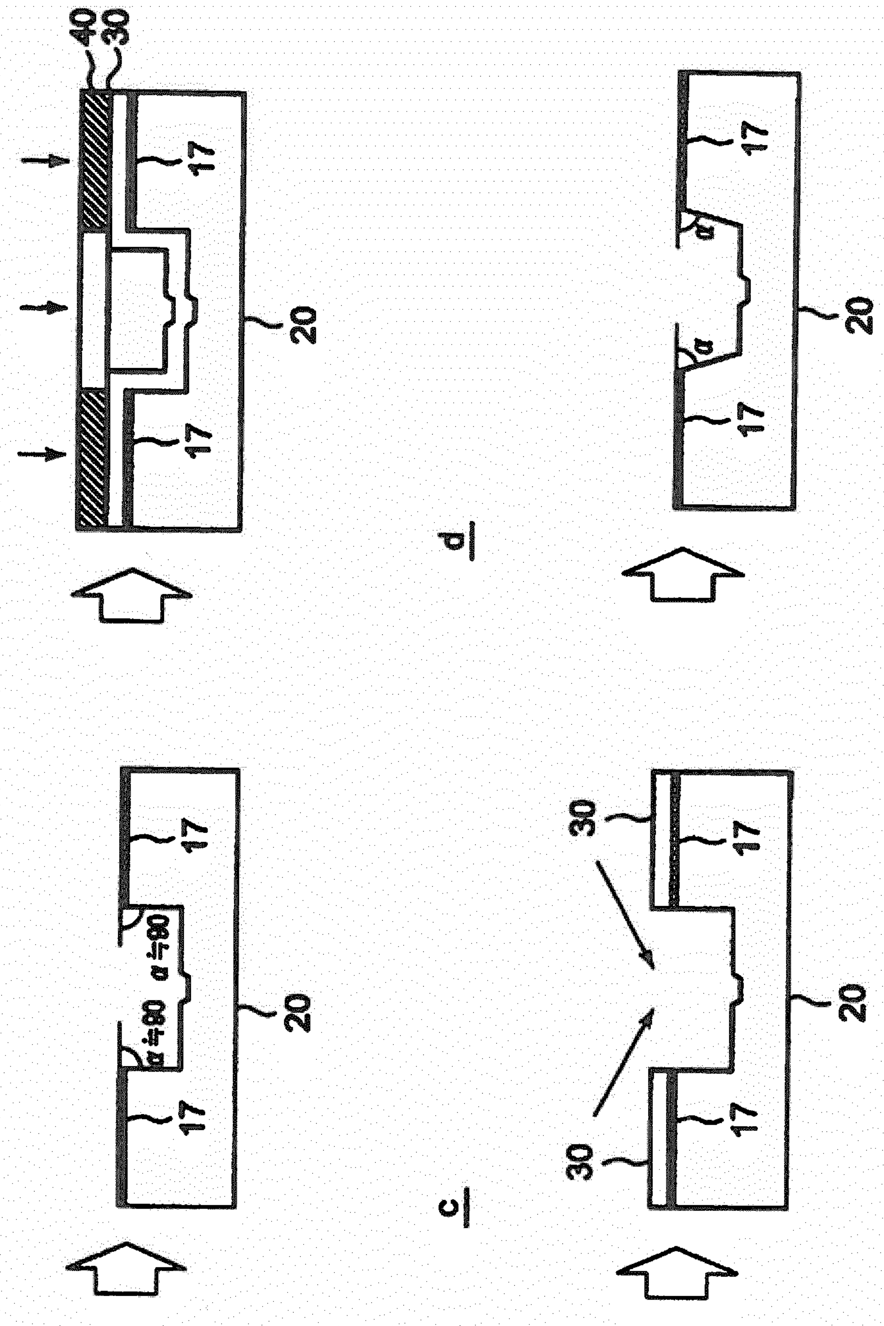


FIG.3

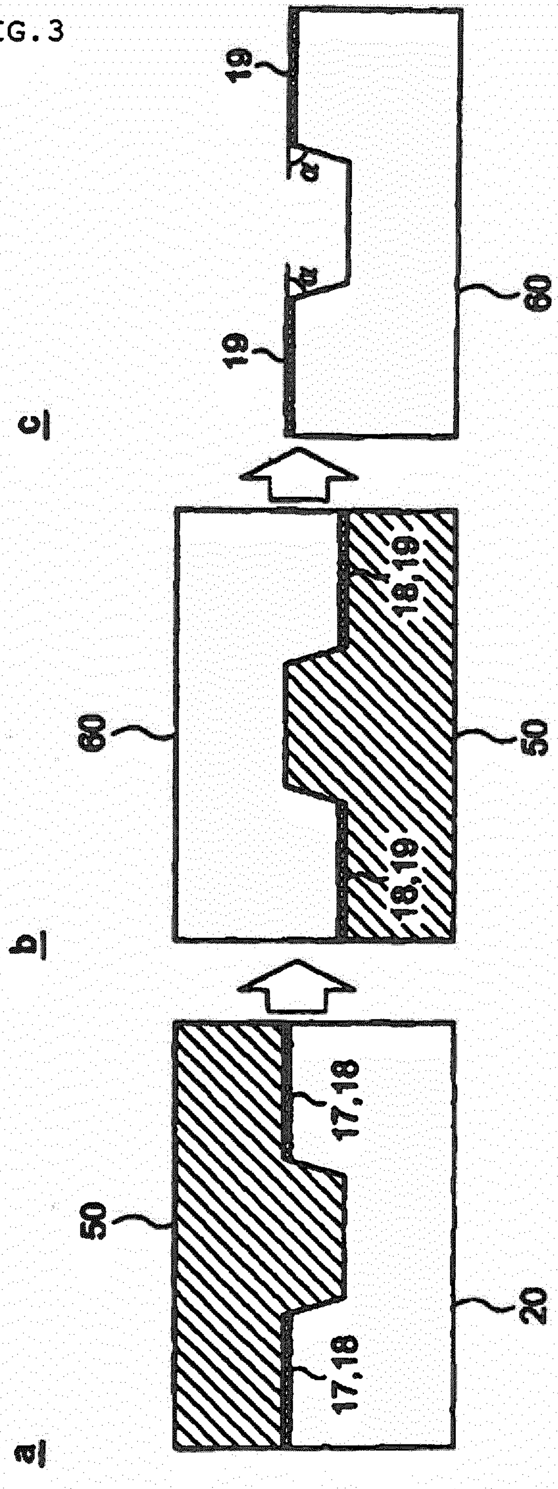


FIG.4

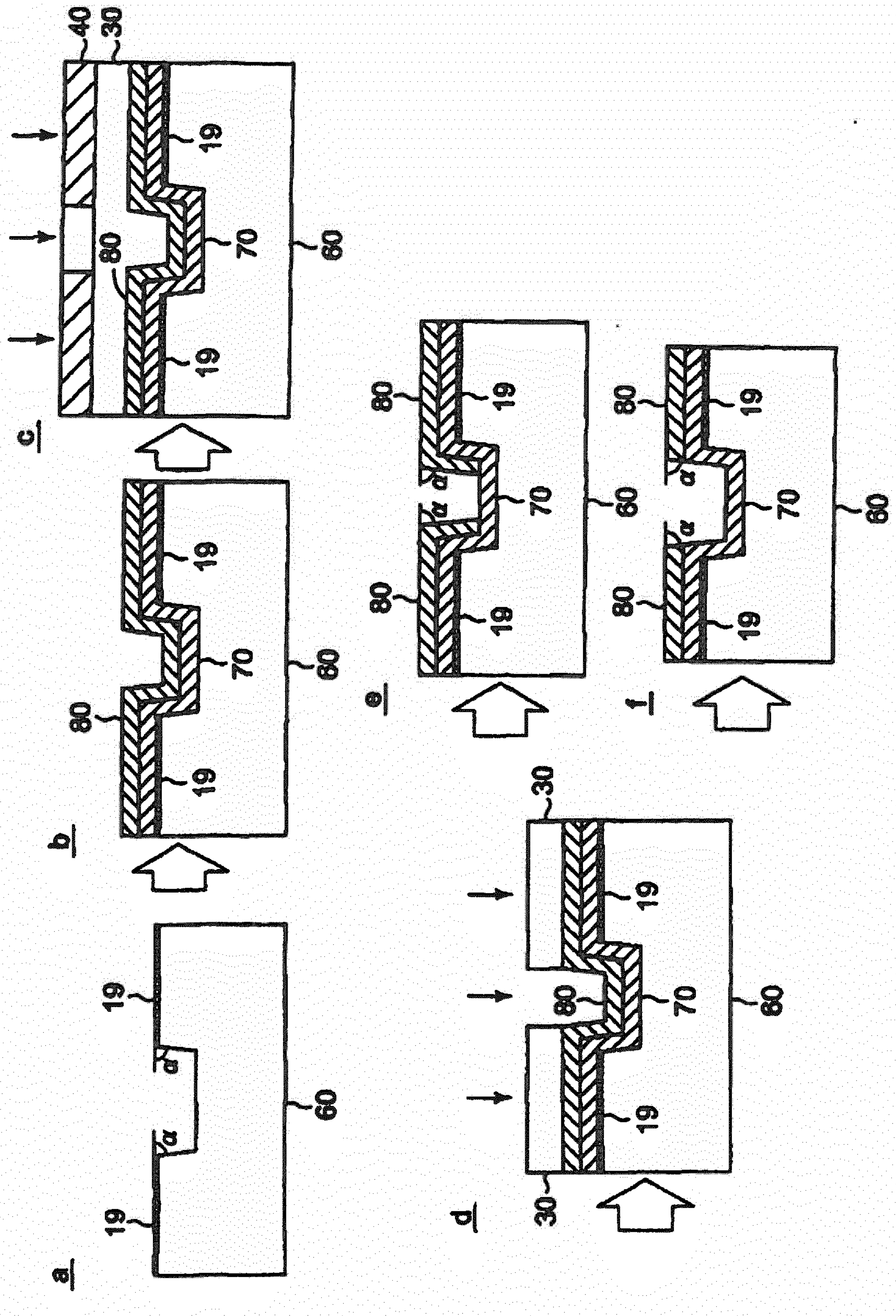


FIG.5

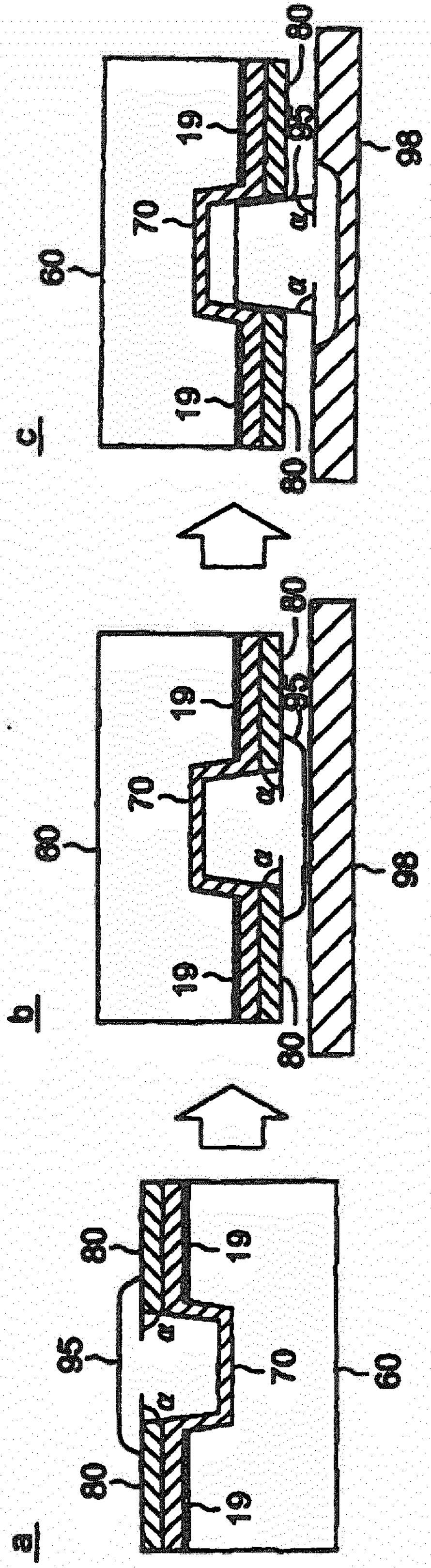
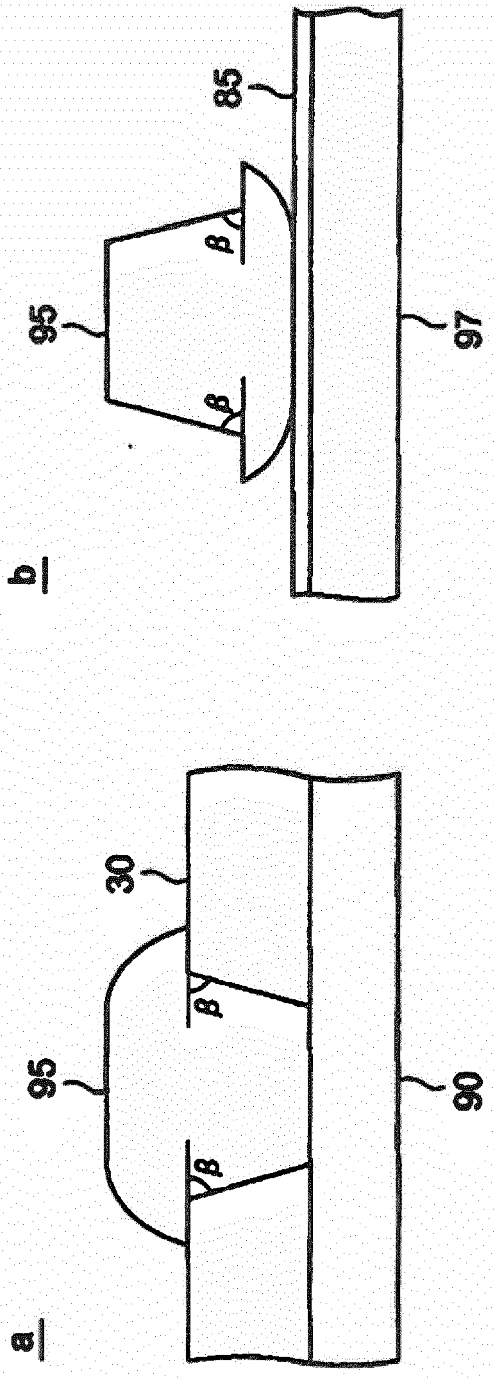

a
80
95
α
α
80
19
19
70
60
b
80
19
60
70
α
α
19
95
80
98
c
80
19
60
70
α
α
19
95
80
98

FIG.6



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2011/006355

A. CLASSIFICATION OF SUBJECT MATTER
C25D1/10(2006.01)i, *B29C33/38*(2006.01)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)
C25D1/10, B29C33/38

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	1996-2012
Kokai Jitsuyo Shinan Koho	1971-2012	Toroku Jitsuyo Shinan Koho	1994-2012

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.
X Y A	JP 10-50576 A (Sumitomo Electric Industries, Ltd.), 20 February 1998 (20.02.1998), entire text (Family: none)	1,7 2-3,8-9 4-6
Y A	JP 1-246391 A (Ricoh Co., Ltd.), 02 October 1989 (02.10.1989), fig. 1 (Family: none)	2,8-9 5
Y A	JP 11-7663 A (Mitsubishi Chemical Corp.), 12 January 1999 (12.01.1999), fig. 1 (Family: none)	2,8-9 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 14 February, 2012 (14.02.12)	Date of mailing of the international search report 28 February, 2012 (28.02.12)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

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

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2011/006355

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	JP 2004-340661 A (Yamaha Corp.), 02 December 2004 (02.12.2004), fig. 1 (Family: none)	3 6
Y A	JP 2005-335345 A (Gyokutoku Kagi Kofun Yugen Koshi), 08 December 2005 (08.12.2005), paragraph [0015]; fig. 8 (Family: none)	3 6
A	JP 48-41936 A (Kabushiki Kaisha Shokosha), 19 June 1973 (19.06.1973), (Family: none)	1-2
A	JP 2006-330080 A (Hitoshi YAMAMOTO), 07 December 2006 (07.12.2006), (Family: none)	1-2
A	JP 2011-195911 A (Seiko Instruments Inc.), 06 October 2011 (06.10.2011), (Family: none)	1-2
A	JP 2006-317807 A (Matsushita Electric Industrial Co., Ltd.), 24 November 2006 (24.11.2006), (Family: none)	4-5

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

REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

- JP 2004001535 A **[0009]**
- JP 2004257861 A **[0009]**