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(56) Documents Cited
EP 0626461 A EP 0561120 A
Patent Abstracts of Japan, vol 18, no 128, [C-1174] & JP0503 11357A

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(54) Abstract Title

Shadow mask for colour crt and method of fabricating the same

(57) A shadow mask for a color CRT is made of an Re-Ni series alloy, preferably consisting of 35 ~ 38% Ni, 0.1 ~ 1.0% Mn. 0.05 ~ 0.5% Cr, 0.05 ~ 0.01% B, below 0.02% C, 0.001 ~ 8.0% Co, 0.001 ~ 0.01% N, below 0.008% O, below 0.1% of at least one of Ti, Er, Mo, V, Nb, Be, P, and the balance of Fe by weight, and has a {100} cube orientation crystal plane concentration of 15 ~ 35% and an average grain size of 3 ~ 15μm. The method of making the shadow mask includes the steps of hot rolling and annealing a slab of Fe-Ni alloy, obtained either by melting in a converter or an electric furnace and casting into an ingot and rolling, or by continuous casting, cold rolling the plate so formed for a first time and annealing for a first time, cold rolling for a second time and annealing for a second time, temper rolling and annealing to obtain a thin plate having a 15 ~ 35% concentration of a {100} crystal planes, with a 3 ~ 15μm average grain size, applying a coat of photoresist, exposing and developing the photoresist, etching the thin plate, and shaping the thin plate and coating it with black iron oxide.

GB 2 336 713 A

FIG.1

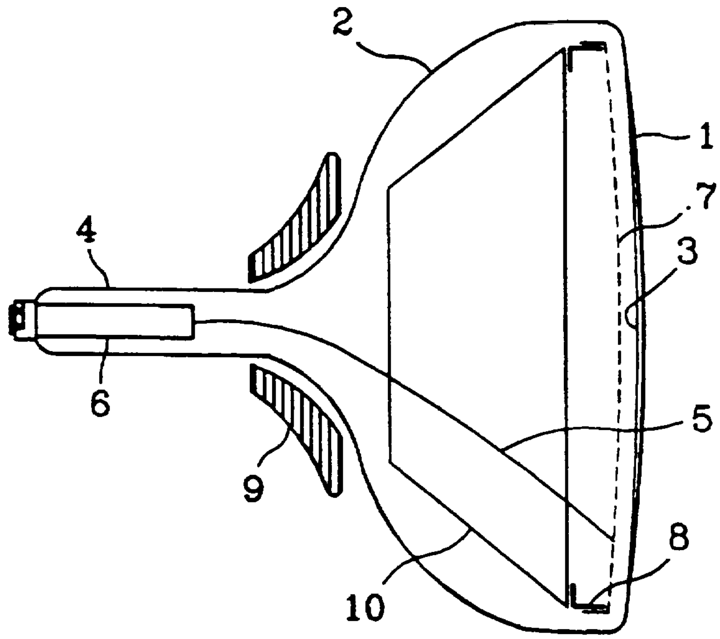


FIG.2

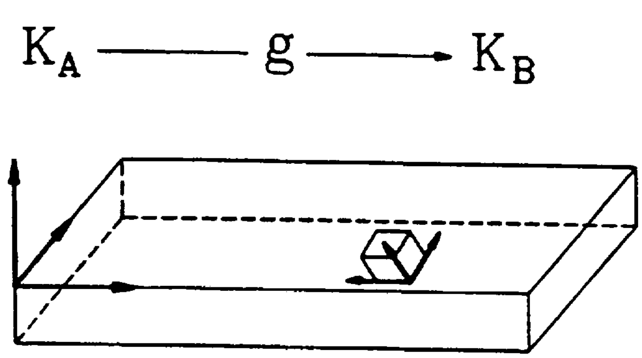
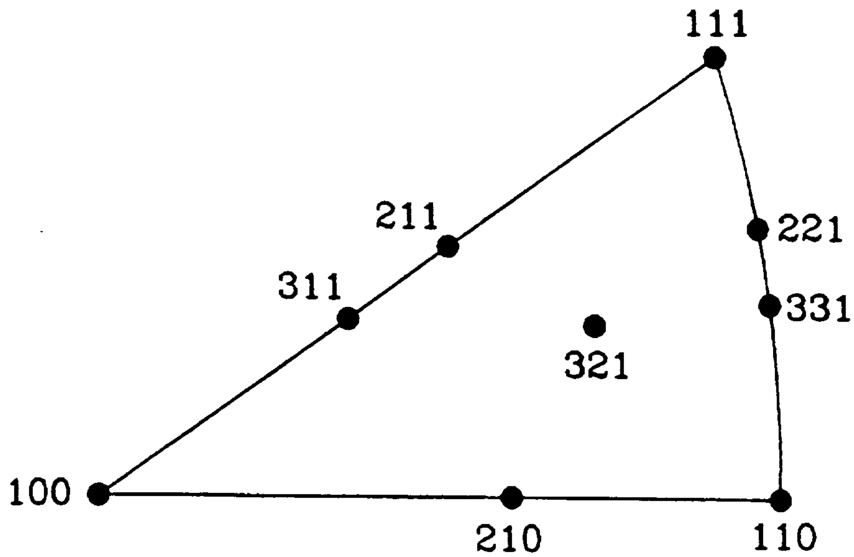


FIG.3



SHADOW MASK FOR COLOR CRT AND METHOD OF FABRICATING THE SAME

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a shadow mask for a color CRT, of an Fe-Ni series invar (RTM) alloy of which alloy composition, crystal grain size, and concentration of {100} crystal planes are adjusted so as to have an excellent etchability and formability, for forming uniform electron beam pass-through holes with a less etching deviation and better roundness by etching; and method for fabricating the same.

Discussion of the Related Art

Referring to Fig. 1, a color CRT(Cathode Ray Tube) is provided with a panel 1 coated with fluorescent films 3 on an inside surface thereof, a funnel 2 coated with conductive graphite on an inside surface thereof and fusion welded to the panel 1 with a glass at approx. 450°C in a furnace, an electron gun 6 in a neck portion 4 of the funnel 2 for emitting electron beams 5, the shadow mask 7, being a color selection electrode, supported by frames 8 on an inner side of the panel 1, and deflection yokes 9 for deflecting the electron beams in left and right directions. The reference numeral 10 denotes an inner shield.

When a video signal is provided to the aforementioned color cathode ray tube, thermal electrons are emitted from cathodes in the electron gun and travel toward the panel, while being accelerated and focused by different electrodes in the electron gun. In the travel, the electron beams are involved in adjustment of its travel path by a magnetic field from the deflection yokes 9 on the neck portion of the funnel, for scanning an entire surface of the panel. The deflected electron beams are selected of a color as they pass through a slot in the shadow mask supported from an inside frame of the panel and collide on different fluorescent films on the inside surface of the panel, to generate light, thereby reproducing the video signal.

A rimmed iron in JIS G3141 series or an aluminum killed steel(AK steel). being a pure iron. has been used as a material of the background art shadow mask in a color cathode ray tube. However. because of the great thermal expansion coefficients of these materials(pure steel : $11.5x10^{-6}deg^{-1}$) and the screen currently developed for a high definition TV. a thermal expansion of the shadow mask by heat from collision of the electrons emitted from the electron gun onto the shadow mask causes doming. which is a color dispersion occurred when the electron beams collide on fluorescent surface of a color other than a designated color due to the thermal expansion. In order to prevent the doming. an invar alloy of Fe-Ni series with a smaller thermal expansion coefficient($1.5x10^{-6}deg^{-1}$) is employed.

The shadow mask is fabricated as follows.

A slab from casting of a steel of an invar composition molten in a converter or an electric furnace is subjected to hot rolling, annealing, acid cleaning and cold rolling, to form a thin plate with a thickness of 0.1 ~ 0.5mm. In the cold rolling. a plural times of rolling is conducted depending on a reduction ratio. Then. an intermediate annealing is conducted at a temperature over 800°C. temper rolled for thickness and surface roughness adjustments and annealed. Surface is cleaned and dried. a coat of photoresist applied. exposed and developed. etched by a ferrous chloride solution. and the photoresist is removed. cut and so on to obtain a circular plate with holes. The circular plate is then cleaned. dried. annealed at a temperature over 800°C. hot pressed. black iron oxide coated. weld assembled and packed. to obtain a shadow mask as shown in Fig. 1.

As the shadow mask of invar alloy has a small thermal expansion coefficient. facilitating to form an exact pass of the electron beams irrespective of a temperature. the invar alloy is widely used as a material of shadow masks suitable for display of high definition TV broadcasting systems and computers which require a high definition still image. In order to obtain a high definition shadow mask of such an invar alloy. small pitched uniform holes should be formed in a shadow mask material by etching. However. despite of its low thermal expansion coefficient. since the invar alloy is a material which is not etched well with a difficulty in obtaining uniform holes. etchability of the invar alloy has been an important subject to be solved. For example. Japanese laid open patent No. S61-82453 restricts a carbon content to be below 0.01% and Japanese laid open patent No. S61-84356 restricts non-metallic contents. for improvement of the etchability. And. Japanese patent publication No. S59-32859. Japanese patent publication No. S61-19737, Korean patent publication No. 88-102 and 87-147, and U.S. PAT. 4. 528.246 claim that a shadow mask material of invar alloy with an concentration over 35% of {100} crystal planes obtained by controlling the cold rolling and annealing in a shadow mask raw material forming process permits a good etching to facilitate formation of uniform electron beam pass-through holes. resulting in an improvement of the doming, that allows a fine color reproduction. However. the background art invar alloy material shows S. B, N impurities even when a carbon content is below 0.01%. Since the impurities are segregated from crystal grains or exist as interstitional atoms in crystal when annealed. affecting to etching. the impurities should be put under control. And. because an {100} crystal plane has the fastest etch rate. if the {100} planes are agglomerated in a rolled surface. the etching can be carried out efficiently. However. if the {100} crystal plane concentration is high. the fast etching causes formation of non-round holes, particularly. if the concentration is over 95%. the holes are formed etched along the crystal plane, resulting in formation of holes which are not round and non-uniform. Therefore. the concentration of the {100} crystal planes over 35% as Japanese patent publication No. S61-19737 claims may not be a satisfactory concentration of crystal texture for etching. Because an etchability is influenced by crystal grain sizes, composition of elements, formation process conditions, orientations of the crystal grains, and the like in combination.

SUMMARY OF THE INVENTION

Accordingly, the present invention is directed to a shadow mask for a color cathode ray tube and addresses one or more of the problems due to limitations and disadvantages of the related art.

It would be desirable to provide a shadow mask for a color cathode ray tube, which has uniform electron beam pass through holes with an excellent roundness and a small etching deviation formed by etching by controlling raw material composition, formation process conditions, texture, and crystal grain for improvement of etchability and formability.

Features and advantages of embodiments of the invention will be set forth in the description which follows, and in part will be apparent from the description, or may be learned by practice of the invention. Other advantages of embodiments of the invention will be realized and attained by the structure particularly pointed out in the written description and claims hereof as well as the appended drawings.

Accordingly, the present invention provides a shadow mask for a color cathode ray tube ______________________________ formed of a shadow mask raw material with a good etchability and a good formability, the raw material includes Fe and Ni as main compositions, with a {100} orientated crystal plane concentration of 15 ~ 35% and an average grain size of 3 ~ 15μm. Preferably, the shadow mask raw material consists of 35 ~ 38% Ni, 0.1 ~ 1.0% Mn, 0.05 ~ 0.5%Cr, 0.05 ~ 0.01% B, below 0.02% C, 0.001 ~ 8.0% Co, 0.001 ~ 0.01% N, below 0.008% O, below 0.1% of at least one of Ti, Er, Mo, V, Nb, Be, P, and the balance of Fe by weight.

The present invention also provides a method of fabricating a shadow mask for a color cathode ray tube, comprising the steps of hot rolling, and annealing a slab_________________ obtained from steel with Fe and Ni as main compositions, melt in a converter or an electric furnace, and cast into ingot and rolled, or continuous cast, cold rolling for the first time and annealing for the first time, cold rolling for the second time and annealing for the second time, temper rolling and annealing, to obtain a thin plate having a 15 ~ 35% concentration of a {100} crystal planes, with a 3 ~ 15μm average grain size, applying a coat of photoresist, subjected to exposure and development and etching, and forming to take a shape, and coating black iron oxide.

It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory and are intended to provide further explanation of the invention as claimed.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this specification, illustrate embodiments of the invention .

In the drawings:

Fig. 1 illustrates a structure of a color cathode ray tube;

Fig. 2 illustrates relations between a crystal grain orientation and test piece coordinates; and,

Fig. 3 illustrates locations of orientations in an inverse pole figure.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Reference will now be made in detail to the preferred embodiments of the present invention. examples of which are illustrated in the accompanying drawings.

Most metals are composed of small polycrystalline grains which seldom exhibit random orientation. but exhibit a preferred orientation(or texture) through a plastic deformation by a hot or cold processing or a manufacturing process, such as heat treatment. which causes a crystalline structural change. with changes of mechanical, magnetic and chemical properties of the metal. particularly. in a case of a re-crystallized cubic lattice. such as a face centered cubic lattice of an invar alloy of a shadow mask material, a good etching is dependent on an orientation of the crystal. Though the etching is done the better as textures oriented in {100} crystal plane is the more. a three dimensional analysis of the crystal orientation in a material is required for a correct understanding of the etching property.

First of all, for better understanding of a texture. it is necessary to set up a relation between a crystal orientation in each test piece and a test piece coordinate system as shown in Fig. 2 for defining a distribution of orientations of crystal grains. If it is assumed that a direction of rotation required for transformation of a test piece coordinate system K_A to a crystal coordinate system K_B is "g". the texture may be expressed as an orientation distribution function f(g). representing a volumetric fraction of crystals in a particular direction "g" in the test piece and a multiple of random orientation without texture. The direction "g" may be represented with Euler angles $\{\Phi_1, \Psi, \Phi_2\}$. or with Miller index (hkl)[uvw]. A plate may be represented with Miller index. setting up coordinates. with (hkl) representing for a plane parallel to a rolling direction and [uvw] representing for the rolling direction as below.

$$f(g)_{(hkl)[uvw]} = \frac{dV(g)_{(hkl)[uvw]}/V}{dg_{(hkl)[uvw]}} \quad \text{------------------------} (1)$$

Where, $g = \{\Phi_1, \Psi, \Phi_2\}$, and V is a volume of the test piece.

In the shadow mask of an invar alloy of a face centered cubic lattice, diffraction intensities of crystal grains are measured by X-ray diffraction using a goniometer while rotating four pole figures of {111}, {200}, {220}, {311} in all possible directions. The diffraction intensity is proportional to a volume of crystal grains on the particular plane {hkl} in a test piece consistent with a diffraction plane. Thus, the four pole figures of {111}, {200}, {220}, {311} are measured, a full orientation distribution function is calculated using a harmonic method and a positivity, a inverse pole figure is calculated for each crystal plane with respect to a direction perpendicular to plate surface, and diffraction intensities $R_{\{111\}}, R_{\{200\}}, R_{\{220\}}, R_{\{311\}}$ of each of the crystal planes are calculated by an equation shown below, and are shown at locations on an inverse pole figure as shown in Fig. 3. [For reference, {100} and {200}, and {110} and {220} are equivalent crystal planes].

$$R_{(hkl)} = \frac{1}{2\pi}\int f(g)\, d\Psi \quad \text{----------------------------------} (2)$$

Where ψ is a projected area of a crystal plane {hkl} on a particular test piece direction in an orientation space.

In the present invention, an invar alloy is prepared to have a concentration of the diffraction intensity $R_{\{100\}}$ of {100} crystal planes to be 15% ~ 35% with an average grain size of 3~15μm based on the $R_{\{111\}}, R_{\{200\}}, R_{\{220\}}$, and $R_{\{331\}}$ calculated by the above equation, to improve an etchability and a geomagnetism cut-off capability, resulting to obtain a shadow mask with uniform holes due to less etch deviation with an excellent roundness.

$$\text{Concentration of } \{100\} (\%) = \frac{R_{\{100\}}}{R_{\{100\}} + R_{\{111\}} + R_{\{311\}} + R_{\{110\}}} \cdot 100 \quad \text{-- (3)}$$

When the concentration of the {100} crystal plane is less than 15%, the etchability drops, and when it is greater than 35%, the etchability may be improved, but a problem of an etchability drop may be caused when a texture with {311}, {110}, and {112} crystal planes has a high concentration than the texture with {100} crystal planes. And, when the grain size is less than 3μm, though the etchability may be improved, a formability can be dropped due to an increased yield strength, and when the grain size is greater than 15μm, an etch rate may be dropped due to greater gain size with non-uniform forms of holes.

With regard to alloy compositions for the shadow mask, Ni and Co are used for adjusting a thermal expansion property, N, C, Ti, Zr, B, Mo, V, Nb, Be, P are used for suppressing grain growth, and B, Cr, Mn are used for securing a hot formability.

Function and content of the aforementioned elements in the invar alloy will be explained.

Ni : Nickel is a major composition in a shadow mask of Fe-Ni invar alloy, with a 35wt% ~ 38wt% content to a total weight for having a low thermal expansion coefficient of below 2×10^{-6}/°C, and preferably 35.5 ~ 36.5wt%. If the content is either below 35wt% or above 38%, the thermal expansion is increased sharply, increasing a doming in the color cathode ray tube.

Co : Cobalt acts as a agent for controlling a thermal expansion and improving an etchability in the invar alloy of the shadow mask, with a content of 0.001 ~ 1.0% in an Fe-36%Ni series. If the content is below 0.001%, the cobalt can not serve for improvement of the thermal expansion, and if greater than 1.0wt%, the thermal expansion is increased.

Mn : Manganese improves a thermal formability in an invar alloy thin plate formation.

with a content of 0.1 ~ 1wt%. If the content is over the upper limit, a hardness of the invar alloy rises, and it the content is below the lower limit, there is no improvement in the thermal formability.

Cr : Chromium improves an adhesion of black iron oxide coating to the invar alloy in the black iron oxide coating process after subjecting the invar alloy thin plate to invar mask etching, annealing, and forming, with a content of 0.05 ~ 0.5wt%. If the content is greater than the upper limit, a hardness of the invar alloy rises, causing possible defects at edges of the invar mask in formation of the invar alloy, a thermal expansion coefficient of the invar alloy rises. If the content is below the lower limit, the adhesion of the black iron oxide coating to the invar alloy is dropped.

B : Boron improves a thermal formability and forms finer grains in formation of an invar alloy thin plate, with a content of 0.005 ~ 0.01wt%. If the content is higher than the upper limit, a hardness of the invar alloy rises, and a segregation of nitrogen as boron nitride is caused at grain boundaries in re-crystallization of Fe-Ni alloy during annealing after rolling, that drops an etchability with a poor surface condition. If the content is below the lower limit, grain growth is caused, and there is no formability improvement.

N : Nitrogen, an element entrained into the invar alloy in formation of the invar alloy thin plate, acts as an agent controlling a grain size. The nitrogen content in the invar alloy is 0.001 ~ 0.01wt%. If the nitrogen is added over the upper limit, grain is grown too small, with a rise of a yield strength, that causes poor formability. If the nitrogen content added to the invar alloy is below 0.001wt%, the grain growth can not be controlled to a desired grain size, with a failure in obtaining a desired etchability.

C : Carbon is added as a reducing agent and a grain growth inhibitor in the formation of invar alloy thin plate. with a content below 0.02%. If the content is greater than the upper limit. a carbide is produced. dropping the etchability and raising a yield strength. that causes a poor formability. and dropping a magnetism. that causes a poor geomagnetism property.

Ti. Mo. V, Zr. Nb. Be. P : These elements are added as unavoidable impurities. and act as grain growth inhibitors. improves adhesion of the black iron oxide coating. However. if a total impurity content exceeds 0.1wt%. a hardness rises, causing to fail in obtaining a level of yield strength required for forming even after annealing.

Si : Silicon acts as a reducing agent in the formation of invar alloy thin plate. with a content below 0.1wt%. If the content is higher than this. the yield strength rises. with a poor formability caused.

O : Oxygen is an unavoidable component entrained in formation of the invar alloy thin plate. If the oxygen content is high. oxide series non-metallic inclusions are increased, dropping the etchability with a poor etch surface. Accordingly. the oxygen content is suppressed to be below 0.008wt%.

The invar alloy shadow mask of the present embodiment is fabricated according to the following steps.

A slab obtained from steel with the aforementioned composition. melt in a converter or an electric furnace. and cast into ingot and rolled. or continuous cast. is hot rolled into steel plate with a thickness of 2 ~ 5mm at a temperature higher than 1000°C. and annealed at a temperature higher than 900°C. The annealed steel palate is acid cleaned. and cold rolled for the first time into a thin plate with a thickness of 0.5 ~ 1.0mm. In the first cold rolling. the cold rolling may be conducted plural times. with a reduction ratio for one time of cold rolling set to be in a range of 45 ~ 60%. In continuation to the first cold rolling. the thin plate is annealed for the first time under a hydrogen ambient at a temperature ranging 1000 ~ 1200°C and subjected again to cold rolling for the second time to obtain a thin plate of 0.1 ~ 0.5mm. In conducting the second cold rolling, the cold rolling may be conducted plural times, with a reduction ratio compared to a thickness in the first time cold rolling set to be in a range of 50 ~ 80%. A number of times of the cold rollings and the reduction ratios may be adjusted appropriately, and the number of times is not limited in the present invention. In continuation to the second time cold rolling, the plate is annealed for the second time, temper rolled with a reduction ratio below 5% in the purposes of thickness and surface adjustments, and annealed at a temperature of 600 ~ 1000°C. Thus, by passing though the aforementioned steps of process, the invar alloy thin plate can have a 15 ~ 35% concentration of the {100} crystal planes, with a 3 ~ 15μm average grain size. The thin plate from the aforementioned process is cleaned and dried, a coat of photoresist applied, exposed and developed, etched by a ferrous chloride solution, cleaned and dried, to fabricate a shadow mask with holes for passing of the electron beams, and formed to take a shape, and black iron oxide coated, to obtain a completed shadow mask. Accordingly, in comparison to the background art in which a separate annealing is conducted in a color cathode ray tube manufacturer for formation, in the case of the shadow mask of the present invention, no separate annealing in the color cathode ray tube manufacturer is required for formation. If necessary, an annealing may be conducted at a temperature ranging 800 ~ 1000°C for a better formability after etching before the forming in the fabrication of the color cathode ray tube.

In the present embodiment ______________________________

raw materials are mixed in compositions, by weight %, of Fe 63%, Ni 36%, Mn 0.2%, Cr 0.1%, C 0.01%, Mo 0.003%, Si 0.05%, B 0.005%, N 0.005%, Co 0.8%, melted together under a vacuum, to obtain an ingot, subjected to continuous hot wire drawing into 8mm diameter wire and lengthwise forging, to obtain a plate 2.0mm thick and 100mm wide. The plate is then subjected to hot rolling at 1100°C, annealed at 1030 °C, a plural times of continuous cold rolling for the first time with one time reduction ratio of 57% to form a 0.4mm thick plate, annealing at 1000°C for more than 1 hour in a hydrogen ambient, and cold rolling for the second time with a 70% reduction ratio. And, in continuation, the thin plate is then subjected to annealing for the second time at 1000°C, temper rolling with a reduction ratio of 5%, and annealing at 800°C for 30min., to form a shadow mask plate material with a 15 ~ 35% concentration of the {100} crystal planes and a thickness of 0.114mm. The plate is then etched with a 38% ferrous chloride solution, to form electron beam pass-through holes and formed to take a shape. The etched thin plate may be annealed at 900°C for 30min. additionally before the formation.

Base materials of the invar shadow mask is prepared with varied process conditions, etchabilities are evaluated by evaluating a {100} crystal plane concentration and grain size before the etching, and a shape freeze is evaluated after annealing at 900°C for 30min. and the formation, of which results are shown in TABLE 1 with comparative examples. The invar shadow mask materials taken as the comparative examples are those formed according to Japanese Laid Open Patent No. S61-19737 with a {100} crystal plane concentration over 35%.

TABLE 1

	anneal before forming	{100} plane concentration (%)	grain size (μm)	etching factor	roundness	shape freeze
Embodiment 1	No	34.8	8	1.95	1.02	0
Embodiment 2	No	28.6	7	2.03	1.01	0
Embodiment 3	No	27.5	8	2.05	0.997	0
Embodiment 4	No	21.7	10	1.89	0.995	0

Embodiment 5	No	19.6	12	1.92	0.99	0
Embodiment 6	No	13.5	18	1.84	0.98	1
Embodiment 7	No	14	27	1.45	0.96	2
Embodiment 8	Yes	16.2	14	1.90	0.99	0
Example 1	Yes	68	11	1.8	0.95	2
Example 2	Yes	89	10	1.89	0.997	0
Example 3	No	37	22	1.62	0.94	8

It can be known from TABLE 1 that an invar shadow mask having good etchability and formability can be fabricated when the {100} crystal plane concentration is 15 ~ 35% with a 3 ~ 15μm crystal grain size even if no annealing is conducted after the etching. On the other hand, it can not be said that a good etchability can be secured without fail even if a concentration of the {100} crystal plane is over 35%. It is found that, if the {100} crystal plane concentration is below 15%, a crystal grain size is increased on annealing after the temper rolling, with a drop of etchability and a shape freeze.

The aforementioned embodiments and comparative examples are evaluated as follows.

* {100} crystal plane concentration : Diffraction intensities of crystal grains of invar shadow mask are measured by X-ray diffraction using a goniometer while rotating four pole figures of {111}, {200}, {220}, {311} in all possible directions, a full orientation distribution function(ODF) is calculated using a harmonic method and a positivity, an inverse pole figure is calculated for each crystal plane with respect to a direction perpendicular to plate surface, and diffraction intensities $R_{\{111\}}$, $R_{\{200\}}$, $R_{\{220\}}$, $R_{\{311\}}$ of each of the crystal planes are calculated by the equation (2), to obtain the {100} crystal plane concentration.

* Crystal grain : Grain is evaluated by means of an optical microscope after polishing, and etching a surface of a plate. Etchant used is 5mℓ HNO_3 + 100mℓ HCl + 200mℓ methanol + 100 mℓ distilled water + $2gCuCl_2$ + 7g $FeCl_3$.

* Etching factor: A depth to side etching ratio is measured by microscope. The etching factor is obtained from a hole etched to 150μm formed by spray of a ferrous chloride solution through a photoresist pattern with a hole of 100μm diameter at etching conditions of 42 Baumé of solution concentration, 50°C. and 2.5Kgf/cm^2.

* Roundness: a ratio of a farthest distance and a shortest distance between two parallel lines drawn to a hole. A roundness ranging 1.10 ~ 0.99 is evaluated good.

* Shape freeze : A shape freeze is evaluated on an extent of distortion, i.e., a ratio of defective shapes at a periphery of the mask after pressing, for 100 samples.

It will be apparent to those skilled in the art that various modifications and variations can be made in the shadow mask for a color cathode ray tube and the method of fabricating the same as described above without departing from the scope of the invention. Thus, it is intended that the present invention cover modifications and variations of the embodiments provided they come within the scope of the appended claims.

CLAIMS:

1. A shadow mask for a color cathode ray tube formed of a shadow mask raw material with a good etchability and a good formability, the raw material comprising Fe and Ni as main compositions and having a {100} cube orientation crystal plane concentration of 15 ~ 35% and an average grain size of 3 ~ 15μm.

2. A shadow mask as claimed in claim 1, wherein the shadow mask raw material consists of 35 ~ 38% Ni, 0.1 ~ 1.0% Mn, 0.05 ~ 0.5%Cr, 0.05 ~ 0.01% B, below 0.02% C, 0.001 ~ 8.0% Co, 0.001 ~ 0.01% N, below 0.008% O, below 0.1% of at least one of Ti, Er, Mo, V, Nb, Be, P, and the balance of Fe by weight.

3. A method of fabricating a shadow mask for a color cathode ray tube, comprising the steps of:

hot rolling, and annealing a slab obtained from steel with Fe and Ni as main compositions, melt in a converter or an electric furnace, and cast into ingot and rolled, or continuous cast;

cold rolling for the first time and annealing for the first time;

cold rolling for the second time and annealing for the second time;

temper rolling and annealing, to obtain a thin plate having a 15 ~ 35% concentration of a {100} crystal planes, with a 3 ~ 15μm average grain size, applying a coat of photoresist, subjected to exposure and development and etching; and,

forming to take a shape, and coating black iron oxide.

4. A method as claimed in claim 3, wherein the shadow mask consists of 35~38% Ni, 0.1~1.0% Mn, 0.05~0.5%Cr, 0.05~0.01%B, below 0.02%C, 0.001~8.0% Co, 0.001~0.01% N, below 0.008% O, below 0.1% of at least one of Ti, Er, Mo, V, Nb, Be, P, and the balance of Fe by weight.

5. A method as claimed in claim 3 or 4, wherein the hot rolling is conducted at a temperature over 1000°C.

6. A method as claimed in any of claims 3 to 5, wherein the first cold rolling is conducted plural times with one time reduction ratio of 45~60%.

7. A method as claimed in any of claims 3 to 6, wherein the second cold rolling is conducted with a reduction ratio of 50~80%.

8. A method as claimed in any of claims 3 to 7, wherein the second annealing is conducted at 1000~1100°C.

9. A method as claimed in any of claims 3 to 8, wherein a temper rolling is conducted after the second annealing with a reduction ratio below 5%.

10. A method as claimed in any of claims 3 to 9, wherein an annealing is conducted at 600~1000°C after the temper rolling.

11. A method as claimed in any of claims 3 to 10, wherein the forming is conducted after etching and annealing.

12. A method of fabricating a shadow mask for a color cathode ray tube substantially as herein described with reference to the accompanying drawings.

13. A shadow mask for a color cathode ray tube fabricated according to the method of any of claims 3 to 12.

14. A shadow mask for a color cathode ray tube substantially as herein described with reference to the accompanying drawings.

15. A colour cathode ray tube comprising a shadow mask as claimed in any of claims 1, 2, 13 or 14.

The Patent Office

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Application No: GB 9908673.8
Claims searched: all

Examiner: Martyn Dixon
Date of search: 15 June 1999

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.Q): H1D (DAD3,DAF4,DAH10,DATX,DPX); B3A (A75)

Int Cl (Ed.6): H01J (9/14,29/07)

Other: Online: EPODOC,WPI,JAPIO

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	EP 0626461 A	(NKK) see especially material nos 1,3,5,7,14-17,32,33 in tables 3-6 & 8-11	1,3,11, 13,15
X	EP 0561120 A	(NKK) see especially material nos 1,3,7,27 & 28 in tables 16-19	1,3,11, 13,15
A	Patent Abstracts of Japan, vol 18, no 128 [C-1174] & JP050311357A (Nikko Kinzoku)		

X Document indicating lack of novelty or inventive step
Y Document indicating lack of inventive step if combined with one or more other documents of same category.
& Member of the same patent family
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