

COLOR DISCRIMINATION MASK FOR COLOR PICTURE TUBE

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BACKGROUND OF THE INVENTION

The present invention relates to a color discrimination mask for a color picture tube, which can be used for any type of color picture tube, e.g. a shadow mask tube or an aperture grille tube, in color television and computer color displays.

In color picture tubes for color television and computer color displays, a mask for color selection is used so that electron beams are applied to predetermined phosphors. As the color selection mask, a shadow mask formed from a metal sheet provided with a large number of small holes or an aperture grille provided with a large number of slits is used. Computer color displays demand a color picture tube with a small pitch that is capable of displaying images of high resolution.

When a color picture tube is used continuously for a long period of time, a color discrimination mask, e.g. a shadow mask or an aperture grille, is heated because accelerated electrons collide against it, and distorted by thermal expansion. This may cause the electron beams to be gradually displaced relative to the phosphor screen, resulting in color shift in the colored image.

Under these circumstances, there has been proposed a technique of preventing color shift due to thermal

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expansion by using a nickel-iron alloy having a low coefficient of thermal expansion, e.g. Invar, as a material for a color discrimination mask in place of the conventional low-carbon steel sheet or the like.

5 However, Invar and other similar alloys suffer from the problem that it is difficult to form fine apertures in the sheets of these alloys in comparison to the carbon steel sheets.

10 As shown in Fig. 1, which is a sectional view of an aperture portion of a color discrimination mask, the color discrimination mask 1 is, in general, etched from both sides thereof to form a small aperture 4 on the electron beam entrance side 2 of the color discrimination mask 1 and a large aperture 5 on the obverse side 3 of the color
15 discrimination mask 1. The diameter of an aperture through which electron beams pass is determined at an intersection 6 of the small and large apertures 4 and 5.

20 In the etching process, etching proceeds not only in the depth direction but also in the horizontal direction at the same time. Therefore, if etching is effected deep, apertures also become large in size in the horizontal direction, resulting in apertures of large diameter.

25 If apertures of excessively large diameter are formed, a correspondingly large amount of metal is removed from the base material. Consequently, the strength of the color discrimination mask reduces undesirably.

 With the upsizing of the display screens of color picture tubes, color discrimination masks have also become

large in size. Furthermore, television and computer displays are now manufactured on a worldwide scale. Therefore, color picture tubes and components thereof are transported over great distances on a global scale. In
5 long-haul transport of large-sized color picture tubes, there is an increasing possibility that they will be vibrated or receive a large impact by falling or other accident during transport. Accordingly, there is a demand for measures to be devised to deal with vibrations and an
10 impact which color picture tubes may receive during transport.

In the case of a stretched color discrimination member, which is held by a frame like an aperture grille, because it is stretched from the upper and lower sides
15 thereof, when the color picture tube receives a large impact, the color discrimination member may be vibrated, but there is a very weak possibility of the color discrimination member being deformed. However, in the case of a color discrimination member that is pressed in
20 conformity to the curved surface configuration of the color picture tube like a shadow mask, when the color picture tube receives a large impact, a part of the curved surface in the center of the color discrimination member may be deformed irrecoverably. Large-sized color picture
25 tubes with large display screens have a better chance of getting damaged. A color picture tube whose surface has an increased radius of curvature and a color picture tube having a flat surface are likelier to get damaged.

When the diameter of the large apertures increases, neighboring apertures may join each other undesirably. Therefore, it is difficult to reduce the pitch between the apertures. Accordingly, it has been difficult to obtain a
5 color discrimination mask having a sufficiently small aperture pitch to provide fine display.

Meanwhile, it has been known that the smaller the grain size of a material used, the smoother the aperture wall surfaces become after etching; therefore, there will
10 be no undesired radiation of electron beams passing through the apertures, and hence a color selection mask of high quality is obtained. However, if the grain size is reduced, the etching rate reduces. Therefore, a long time is needed for etching in comparison to the base material
15 of soft steel. Furthermore, truly round apertures cannot be formed only by reducing the grain size. Therefore, it is impossible to obtain a color selection mask having excellent characteristics.

There is also known a shadow mask formed by using a
20 nickel-iron alloy in which trace components of the material and the surface cleanness are adjusted or the crystal plane orientation is adjusted to a specific direction. However, it has heretofore been impossible to obtain a shadow mask having satisfactory characteristics.

25 An object of the present invention is to prevent degradation of display characteristics due to degradation of the aperture configuration in a color discrimination mask made of a low-expansion nickel-iron alloy and to

eliminate difficulties in achieving a fine pitch, such as a reduction in strength resulting from an increase in diameter of the large apertures and undesired joining of neighboring apertures.

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BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a sectional view of an aperture portion of a color discrimination mask.

Fig. 2 is a diagram illustrating a method of
10 measuring the maximum grain diameter.

SUMMARY OF THE INVENTION

The present invention provides a color discrimination mask for a color picture tube. The color
15 discrimination mask is formed from a nickel-iron alloy steel sheet made of a nickel-iron alloy containing 34% to 38% by weight of nickel. The nickel-iron alloy has a grain size number of not less than 10. The grain diameter in a cross-section in a direction perpendicular to the rolling
20 direction is not larger than 50 μm . The average grain diameter in the elongation direction is not larger than 30 μm . The nickel-iron alloy steel sheet is provided with apertures by etching using a pattern provided on the nickel-iron alloy steel sheet.

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DESCRIPTION OF THE PREFERRED EMBODIMENT

According to the present invention, a color discrimination mask is formed by using a nickel-iron alloy

which has a small grain size and in which the grain diameter in a cross-section cut in a direction perpendicular to the material rolling direction is not larger than 50 μm . The use of such a nickel-iron alloy makes it possible to obtain a color discrimination mask which has a low coefficient of thermal expansion and is superior in the configuration of apertures. Moreover, the diameter of the large apertures provided on the obverse side of the mask is small, and the aperture pitch is reduced. Accordingly, the color discrimination mask enables high-definition display to be performed.

More specifically, the present invention is based on the finding that when subjected to etching, a metal is removed not uniformly but unevenly along the grain boundaries. Therefore, even in the case of a metallic material having a small grain size, if large grains are present, when the large grains are removed by etching, the surface configuration of the apertures degrades along the large grain boundaries.

In the color discrimination mask according to the present invention, the grain size number measured by the grain size measuring method defined by ASTM E112 (JIS G0551) is preferably not less than 10, more preferably not less than 11. If the grain size number is small, truly round apertures cannot be obtained.

The size of the grains is preferably not larger than 50 μm . If grains larger than 50 μm are present, even if the grain size number is 10 or more, the surface

configuration of the apertures degrades, and the roundness also degrades.

The average grain diameter in the elongation direction is preferably not larger than 30 μm . If there is anisotropy in the size of the grains, etching proceeds preferentially in the uniaxial direction. Because the material for a shadow mask is produced by rolling, the grains are not a little elongated in directions perpendicular to the sheet thickness. Accordingly, etching proceeds preferentially in the elongation direction. Consequently, etching proceeds at a higher rate in the directions perpendicular to the sheet thickness than in the direction of the sheet thickness, resulting in undesirably enlarged large apertures.

The above-described roundness is concerned with circular apertures. In the case of slit-shaped apertures or slot-shaped apertures, the linearity of apertures formed by etching can be improved, and it is also possible to reduce the size of apertures formed on the obverse side of the mask. Therefore, it is possible to obtain a color discrimination mask for high-definition display in which fine apertures are arranged at a small pitch.

The present invention will be described below by way of examples.

Example 1:

A nickel-iron alloy steel sheet containing 36% by weight of nickel, which had a grain size number of 11 as measured by the grain size measuring method defined by

ASTM E112 (JIS G0551) and a thickness of 0.12 mm, was coated at both sides thereof with a water-soluble casein resist. After drying, the resists on the two sides of the sheet stock were patterned by using a pair of glass
5 dryplates having predetermined patterns drawn thereon, respectively.

Next, exposure, hardening and baking processes were carried out. Thereafter, the patterned resist surfaces were sprayed with a ferric chloride solution having a
10 temperature of 60°C and a specific gravity of 48° Beh (Baume degree of heavy liquid) as an etching liquid. More specifically, first, etching was carried out from a side of the sheet stock where small apertures were to be formed. After predetermined small apertures had been formed, the
15 side of the sheet stock provided with the small apertures was covered with an acid-resistant resin material, e.g. a paraffin or ultraviolet-curing resin material, so that the small apertures were filled with the acid-resistant resin material. Subsequently, etching was similarly carried out
20 from a side of the sheet stock where large apertures were to be formed, thereby forming large apertures such that they joined the associated small apertures to form through-apertures. Thereafter, the resin material and the resist were removed with an alkaline aqueous solution to
25 obtain a shadow mask having circular apertures.

The characteristics of the shadow mask thus obtained were evaluated by the following evaluation method. The results of the evaluation are shown in Table 1 below.

Example 2:

A nickel-iron alloy steel sheet was etched in the same way as in Example 1 except that the nickel-iron alloy used in this example had a grain size number of 10 and was
5 different from the nickel-iron alloy used in Example 1 in terms of the maximum grain diameter and the average grain diameter in the elongation direction. The characteristics of a shadow mask obtained in this example were evaluated in the same way as in Example 1. The results of the
10 evaluation are shown in Table 1.

Comparative Example 1:

A nickel-iron alloy steel sheet was etched in the same way as in Example 1 except that the nickel-iron alloy used in this example had a grain size number of 9.5 and
15 was different from the nickel-iron alloy used in Example 1 in terms of the maximum grain diameter and the average grain diameter in the elongation direction. The characteristics of a shadow mask obtained in this example were evaluated in the same way as in Example 1. The
20 results of the evaluation are shown in Table 1.

Comparative Example 2:

A nickel-iron alloy steel sheet was etched in the same way as in Example 1 except that the nickel-iron alloy used in this example had a grain size number of 10 and was
25 different from the nickel-iron alloy used in Example 1 in terms of the maximum grain diameter and the average grain diameter in the elongation direction. The characteristics of a shadow mask obtained in this example were evaluated

in the same way as in Example 1. The results of the evaluation are shown in Table 1.

Table 1

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	Grain size	Max. grain diam.in	Av. grain diam.	Uniformity	Aperture configuration	Roundness	Diam.of large aperture	Diam.of small aperture	Aperture diameter	
	No.	diam.	elongation direction							
		(µm)	(µm)			(%)	(µm)	(µm)	(µm)	
10	Example 1	11.0	37	21.8	good	good	99.0	242.6	129.2	127.2
	Example 2	10.0	42	20.5	good	good	98.7	243.0	129.0	127.2
	Comp.Ex.1	9.5	52	42.1	bad	contour undulated	96.1	247.0	131.7	127.0
15	Comp.Ex.2	10.0	52	30.9	bad	contour undulated	97.6	245.2	131.4	127.1

(Evaluation Method)

20 1. Uniformity

Uniformity was visually evaluated by applying light to the shadow mask from the small-aperture side thereof.

2. Aperture configuration

The aperture configuration was observed with a scanning electron microscope.

25 3. Roundness

With respect to one aperture in the shadow mask, the aperture diameter was measured at at least 5 arbitrary

points on the circumference. The roundness was calculated from the following Eq. (1) using the maximum and minimum values of the measured values. The measurement was carried out on at least 5 apertures, and the roundness was
 5 evaluated from the mean value of the measured values.

Roundness (%)

$$= \frac{\text{Aperture diameter minimum value}}{\text{Aperture diameter maximum value}} \times 100$$

10

...Eq. (1)

4. Maximum grain diameter

Fig. 2 illustrates a method of measuring the maximum grain diameter.

15 Part (A) of Fig. 2 is a sectional view of a sample cut by a section perpendicular to the rolling direction. Each of grains 12 constituting a nickel-iron alloy steel sheet 11 has a shape elongated in the rolling direction 13 and crushed in the sheet thickness direction 14 by rolling.

20 Part (B) of Fig. 2 is a diagram illustrating a method of measuring each individual grain, in which measurement is carried out by placing a ground glass having a circle 15 with a preset diameter drawn thereon over a grain 12 to be measured.

25 A ground glass having circles with diameters of 20, 30, 40 and 50 μm drawn thereon was placed over a test piece for grain size number measurement, and observation was made under a microscope with a magnification of 200 to

500. With the circle of 50 μm in diameter placed in the center of the largest grain, a check was made as to whether or not there were two or more regions extending out of the circle. When there were two or more regions, a straight line was drawn from an arbitrary point on the grain boundary of each region extending out of the circle, and a straight line having the maximum length was defined as the maximum grain diameter. When there were not two or more regions extending out of the circle of 50 μm , a similar measurement was made using a smaller circle in the order of decreasing diameter, i.e. 40 μm , 30 μm , and 20 μm . In this way, the maximum grain diameter was measured.

5. Average grain diameter in the elongation direction

The average grain diameter in the elongation direction was obtained from the following Eq. (2):

$$\begin{aligned} &\text{Average grain diameter in the elongation direction} \\ &= d \times N_1 / N_2 \qquad \dots \text{Eq. (2)} \end{aligned}$$

In Eq. (2):

d: average grain diameter; the shape of the grains measured by the grain size measuring method defined by ASTM E112 (JIS G0551) was assumed to be a square, and the length of one side of the square was regarded as an average grain diameter, which was calculated from the square root of the average sectional area;

N_1 : the number of grains cut by a line segment with a predetermined length in a direction (sheet thickness

direction, i.e. z-axis direction) perpendicular to the direction in which the grains were elongated;

N_2 : the number of grains cut by a line segment in a direction (rolling direction or a direction perpendicular to the rolling direction, i.e. x- or y-axis direction) parallel to the direction in which the grains were elongated, the line segment having the same length as that of the line segment used to obtain N_1 .

For each of N_1 and N_2 , measurements were made in at least 5 visual fields using the test piece used to measure the grain size, and the mean value of the measured values was used.

The color discrimination mask for a color picture tube according to the present invention is formed by using a low-expansion nickel-iron alloy steel sheet having a grain size number within a predetermined range and further having a grain diameter within a predetermined range. The nickel-iron alloy steel sheet is provided with apertures by etching using a pattern formed on the sheet. In the case of linear apertures, the linearity of the apertures improves. In the case of circular apertures, the roundness improves. In addition, because the dimensional accuracy of the large apertures provided on the obverse side of the mask can be improved, it is possible to improve the mask strength and hence possible to obtain a mask for high-definition display, which has a fine pitch.



WHAT WE CLAIM IS:

1. A color discrimination mask for a color picture tube, said color discrimination mask comprising a nickel-iron alloy steel sheet made of a nickel-iron alloy
- 5 containing 34% to 38% by weight of nickel, wherein a grain size number is not less than 10, and a grain diameter in a cross-section in a direction perpendicular to a rolling direction is not larger than 50 μm , and further an average grain diameter in an elongation direction is not larger
- 10 than 30 μm , said nickel-iron alloy steel sheet being provided with apertures by etching using a pattern provided on said nickel-iron alloy steel sheet.