

METHODS OF MANUFACTURING PHOSPHOR SCREENS
FOR CATHODE RAY TUBES

5 This invention relates to methods of manufacturing phosphor screens for cathode ray tubes, and to phosphor screens so made.

A known method of manufacturing a phosphor screen for a cathode ray tube, particularly a colour cathode ray tube, is a so-called PVA (polyvinyl alcohol) slurry method.

10 In the PVA slurry method, phosphor particles are suspended in an aqueous solution, which contains a photosensitive resin, such as ammonium bichromate, a dispersing agent (surface active agent) and a binder, such as polyvinyl alcohol, thereby to produce a so-called phosphor slurry. Then, the phosphor slurry is coated on the inner surface of a panel of a cathode ray tube, which already has formed
15 thereon a light absorption layer, for example a carbon stripe. After the phosphor slurry has been dried, it is exposed to light using a colour selection electrode (for example, an aperture grill) as an optical mask. After the exposing process, the colour selection electrode is removed, and the product is developed by water, thereby
20 forming phosphor stripes of a predetermined pattern, to form a phosphor screen on the inner surface of the panel. In general, similar processes are sequentially repeatedly carried out to form a green phosphor stripe, a blue phosphor stripe and a red phosphor stripe. Then, the product is dried and is uniformly coated with an aqueous
25 solution containing, for example, an acrylic resin (for example a resin sold as PRIMAL (RTM)). The product is again dried to form an acrylic resin-based film, which is a so-called intermediate film, on the phosphor stripes. Thereafter, a metal back layer is formed on the intermediate film by an aluminium vapour deposition process, and then
30 the product is baked to remove the intermediate film formed beneath the metal back layer.

In this method, however, as shown in Figures 1A and 1B of the accompanying drawings, phosphor particles 21 are crowded or overlap one another on a panel 22, so that they are brought into surface contact
35 with one another. Each single phosphor particle 21 has many contact portions. Thus, when a phosphor particle 21 is activated by the bombardment of electrons to emit light, the light emitted from the phosphor particle 21 cannot pass therethrough, due to the existence of

many contact portions, and hence the brightness of the phosphor screen is deteriorated. In Figure 1B, reference numeral 23 designates a metal back layer.

Moreover, in the stage for manufacturing the phosphor screen, as shown in Figure 2A of the accompanying drawings, the phosphor particles 21 may be dispersed in a displaced condition, and a so-called pinhole H is formed through the phosphor particles 21 to communicate with the panel 22. The metal back layer 23, which will be formed in the later stage, enters the pinhole H and contacts with or internally touches the inner surface of the panel 22, as shown in Figure 2B of the accompanying drawings. This condition causes the brightness of the phosphor to be lowered considerably.

According to the present invention there is provided a method of manufacturing a phosphor screen for a cathode ray tube, the method comprising the steps of:

preparing a suspension by suspending a phosphor material having an average particle size of 3 to 12 micrometres and resin particles having an average particle size of 5 to 12 micrometres in an aqueous solution containing a photosensitive resin, a dispersing agent and a binder; coating an inner surface of a cathode ray tube with said suspension to form a phosphor screen; forming an intermediate layer on said phosphor screen; forming a metal back layer on said intermediate film; and then baking the product.

The invention will now be described by way of example with reference to the accompanying drawings, throughout which like parts are referred to by like references, and in which:

Figures 1A and 1B are diagrams used to explain a problem of a prior phosphor screen;

Figures 2A and 2B are diagrams used to explain the problem of a pinhole of a prior phosphor screen;

Figures 3A to 3I are process diagrams showing a method of manufacturing a phosphor screen for a cathode ray tube and according to the present invention;

Figures 4A and 4B are diagrams used to explain the action of a phosphor particle and a resin particle;

Figures 5A and 5B are diagrams used to explain the actions of the phosphor material and the resin particle in a pinhole; and

Figure 6 is a graph showing change of a brightness increasing ratio with respect to the diameters of the phosphor material and the resin particles.

Resin particles, for example, polyethylene particles 2 (Figure 3A) were mixed into an aqueous solution 1 containing a photosensitive resin made of ammonium bichromate or the like, a dispersing agent such as a surface active agent and a binder such as a polyvinyl alcohol. Then, phosphor particles of a first colour, for example, green phosphor particles 3 were added to the aqueous solution 1 with the polyethylene particles 2, and the solution 1 was stirred for a few minutes, for example two to three minutes to provide a suspension 4 (Figure 3A). Then, the suspension 4 was uniformly coated on the inner surface of a panel 6 (Figure 3B) on which there were previously formed carbon stripes 5. After the drying process, the product was exposed to light through an optical mask 7 (Figure 3C), such as a colour selection electrode. After the exposing process, the product was developed by water to form a green phosphor stripe 9G, and so-called blank portions 8 formed between predetermined carbon stripes 5 (see Figure 3D). Similarly, phosphor stripes of second and third colours, for example, blue phosphor stripes 9B and red phosphor stripes 9R were formed on the other blank portions 8 (see Figure 3E).

An acrylic resin solution 10 was uniformly coated on the whole surface of the product including the phosphor stripe 9 (9G, 9B and 9R) as shown in Figure 3F, and was then dried to form an acrylic resin-based intermediate film 11 (see Figure 3G). Thereafter, an aluminium film was formed on the intermediate film 11 as a metal back layer 12 by an aluminium vapour deposition process to form a product illustrated in Figure 3H. Then, the product was baked to complete the process (see Figure 3I).

The action of the polyethylene particles 2 on the phosphor particles 3 in the stages from the process for forming the phosphor stripe to the baking process will be described with reference to Figures 4A, 4B, 5A and 5B. For simplicity, only the action of the polyethylene particles 2 in the green phosphor stripe 9G will be described, because the polyethylene particles 2 in the blue and red phosphor stripes 9B and 9R achieve the same or similar actions and effects.

In the stage in which the phosphor stripe 9G is formed, as shown in Figure 4A, the phosphor particles 3 and the polyethylene particles 2 are randomly arranged on the panel 6, and the phosphor particles 3 are not brought into contact with one another due to the existence of the polyethylene particles 2, which separate the phosphor particles 3. When under such conditions, the intermediate film 11 and the metal back layer 12 are formed and the product is wholly baked, the polyethylene particles 2 between the phosphor particles 3 and the intermediate film 11 formed beneath the metal back layer 12 are removed by the baking step (see Figure 4B). Thus, spaces a are formed between the adjacent phosphor particles 3, in particular, where the polyethylene particles 2 were present before, so baking reduces contact between the phosphor particles 3. Thus, the brightness of the phosphor screen will be increased.

In the stage in which the phosphor stripe 9G is formed, if phosphor particles having poor dispersing properties are used, due to the eccentric or displaced dispersion thereof, a pinhole H may be formed in the phosphor stripe 9G. However, the polyethylene particles 2 enter the pinhole H randomly, as well as being between the phosphor particles 3, so that the polyethylene particles 2 fill up the pinhole H (see Figure 5A). If the intermediate film 11 and the metal back layer 12 are formed under the above-mentioned condition, the intermediate film 11 and the metal back layer 12 are prevented from entering the pinhole H, so that they are formed substantially along the upper surface of the phosphor stripe 9G. Thus, when the product is baked, the metal back layer 12 is formed smoothly to cover the upper surface of the pinhole H, as shown in Figure 5B. Under this condition, if electrons strike the phosphor particles 3, then the light emitted from the phosphor particles 3 is reflected on the surface of the metal back layer 12 near the pinhole H by the mirror surface effect of the metal back layer 12, thus preventing the brightness from being lowered by the existence of the pinhole H.

Figure 6 shows how the brightness changes with the particle size of the resin particles (polyethylene particles) 2 relative to the phosphor particles 3.

In the graph of Figure 6, graph lines I, II and III illustrate a change in brightness with an increase in the size of the resin particles 2. Lines I, II and III are for an average particle size of

the phosphor particles 3 of 12, 6 and 3 micrometres, respectively. The average particle size of the resin particles 2 were plotted for 2, 5 and 12 micrometres, respectively.

From Figure 6, it is thus apparent that the larger the average particle size of the phosphor particles 3 and the resin particles 2 becomes, the more the brightness is increased. The reason for this is considered to be, that with the increase of the particle size of the phosphor particles 3 and the resin particles 2 (within the range of particle size for which the phosphor particle can be used as a phosphor material), more space is apt to be produced in the phosphor screen, thus increasing its brightness.

Since, according to the above described method of manufacturing a phosphor screen for a cathode ray tube, the phosphor particles 3 and the resin particles 2 are both suspended in an aqueous solution 1 made of the photosensitive resin, the dispersing agent and the binder to provide the suspension 4, and this suspension 4 is used to form the phosphor stripe 9, resin particles 2 are located between adjacent phosphor particles 3, and the resin particles 2 prevent the phosphor particles 3 from contacting one another. After the baking process, the places in which the resin particles 2 were located are left as the spaces a, so that the phosphor particles 3 are barely in contact with one another. Thus, the light emission of the phosphor particles 3, resulting from bombardment by electrons is more effective, and the brightness of the phosphor screen is increased.

Moreover, in forming the phosphor screen, even when a pinhole H is formed by the displacement or eccentric dispersion of the phosphor particles 3, the resin particles 2 enter and fill the pinhole H. Therefore, when the metal back layer 12 is formed, it is smooth, thus preventing the brightness from being deteriorated due to the existence of metal in the pinhole H.

While in the above-mentioned embodiment, polyethylene particles are used as the resin particles 2, it is possible to use other resins whose particle sizes can be freely selected and which can be completely removed in the baking process (Figure 3I). The resin particles may, for example, be polystyrene particles.

CLAIMS

1. A method of manufacturing a phosphor screen for a cathode ray tube, the method comprising the steps of:
 - 5 preparing a suspension by suspending a phosphor material having an average particle size of 3 to 12 micrometres and resin particles having an average particle size of 5 to 12 micrometres in an aqueous solution containing a photosensitive resin, a dispersing agent and a binder;
 - 10 coating an inner surface of a cathode ray tube with said suspension to form a phosphor screen;
 - forming an intermediate layer on said phosphor screen;
 - forming a metal back layer on said intermediate film; and then baking the product.
 - 15 2. A method according to claim 1 wherein said resin particles are polyethylene.
 3. A method according to claim 1 wherein said resin particles are
20 polystyrene.
 4. A method of manufacturing a phosphor screen for a cathode ray tube, the method being substantially as hereinbefore described with reference to Figures 3A to 3I of the accompanying drawings.
 - 25 5. A phosphor screen for a cathode ray tube, the phosphor screen having been made by a method according to any one of the preceding claims.
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