

DESCRIPTION

COLOR FILTER MANUFACTURING METHOD AND INK JET HEAD

TECHNICAL FIELD

The present invention relates to a method for manufacturing a color filter employed for a liquid crystal display panel or the like, and an ink jet head and, more particularly, to a method for manufacturing a color filter by discharging color ink by an ink jet head, and an improved ink jet head which realizes the color filter manufacturing method.

BACKGROUND ART

In recent years, demand for a liquid crystal display, particularly, for a color liquid crystal display is increasing with the development of personal computers, particularly, that of portable personal computers. However, for a further diffusion, it is required to perform a cost down of the liquid crystal display and, particularly, that for a color filter which has a high weight in view of cost.

As major color filter manufacturing methods, there are a printing method, an electrodeposition

method, a staining method, a pigment dispersion method, or the like. Hereinafter, the respective methods will be described.

The printing method comprises repeatedly pasting three colors of red (hereinafter referred to as R), green (hereinafter referred to as G), and blue (hereinafter referred to as B) on a thermosetting resin which is to be a colored layer, and making the thermosetting resin subjected to heating and curing, thereby to produce colored layers. As paints, those which have pigments dispersed therein are employed.

While this printing method has simple process steps, it has disadvantages that the color filter has deteriorated resolution and flatness.

The electrodeposition method comprises patterning a transparent electrode on a transparent substrate, soaking the same in electrodeposition paint liquid including pigment, resin, electrolyte, and the like, thereby to electrodeposite a first color layer, and repeating this process three times to produce colored layers of R, G, and B, and finally performing burning.

While this electrodeposition method has superiority in flatness of a color filter, it has a

disadvantage that the color arrangement pattern of a color filter that can be formed are restricted.

The staining method comprises adding sensitizing agent to water-soluble polymeric material as a material for staining on a glass substrate, thereby to perform photo-sensitization, and patterning this photo-sensitized layer into a desired shape by a photolithography process, and soaking the obtained pattern in a staining bath, to obtain a colored pattern. By repeating this process three times, colored layers of three colors of R, G, and B are obtained.

While this staining method provides a colored filter having a sharp color, it has disadvantages of being inferior in resistances to weather, light, and heat, as well as in hygroscopicity of a color filter.

Finally, the pigment dispersing method comprises producing a pigment-dispersed photosensitive resin layer on a substrate, patterning the same to result a monochromatic pattern, and repeating this process three times to produce colored layers of three colors R, G, and B.

This pigment dispersing method has a disadvantage that 70% or more of the applied material is disposed of at the patterning, thereby

resulting in a substantial material loss.

In any of these four methods, it is general that a protective layer is produced on a colored layer.

Also any of the above-described four methods requires repeating the same process three times to produce colored layers of three colors R, G, and B, thereby necessarily resulting in a high manufacturing cost as well as a low yield and a low productivity.

As methods which can solve these disadvantages, color filter manufacturing methods employing an ink jet method have already been proposed, and are disclosed in Japanese Published Patent Application No. Sho. 59-75205, 63-235901, No. Hei. 1-217302, 4-123005, 7-146406, and the like.

This ink jet method comprises discharging coloring liquid (hereinafter referred to as ink) including each pigment of R, G, or B onto a color filter substrate from nozzles, and drying the ink on the transparent substrate which is to be a color filter, thereby to produce a colored layer.

According to this ink jet method, the production of the respective colored layers of R, G, and B can be carried out at once as well as there is

no waste in the quantity of used ink, thereby resulting in advantages of a substantial increase in productivity, a cost reduction, and the like.

As ink jet methods, there are two methods, and one of them comprises directly pigmenting part to be colored of a color filter with ink of each color employing a thermal ink jet head (also referred to as "bubble jet head") which discharges droplets utilizing thermal energy, or a piezo head which discharges droplets utilizing direct mode deformation (the property of deforming of the piezoelectric ceramics) of piezoelectric element, and the other of them comprises previously producing an ink accepting layer with liquid-absorbing material such as cellulose, acrylic series resin, gelatin, and the like, and staining this with discharged ink.

First, the method of directly pigmenting a color filter substrate comprises discharging ink droplets into a pixel section partitioned by frames (black matrix) on a color filter substrate, to fill in the pixel section with a predetermined quantity of ink, and drying and solidifying the ink, thereby to produce a colored layer.

Meanwhile, in order to assure the flatness

between the frame and the colored layer, the height of the frame is restricted to the height of ink when being dried and solidified. Therefore, in prospect of volume decrease due to drying, ink of a volume exceeding the height of the frame is filled in, and this ink produces a convex meniscus to be held stably, by including fluoro series material in the frame which is composed of photosensitive resin material, which results in adding liquid repellent characteristics to the resin.

A method of discharging and filling in ink in this frame by the ink jet head will be described with reference to figure 8.

Figure 8 is a schematic diagram illustrating a color filter manufacturing method by a conventional ink jet method which directly pigments a color filter substrate, in a case where four ink droplets are discharged into a pixel section.

Figure 8(a) illustrates a state before the first ink droplets is dropped, figure 8(b) illustrates a state before the second ink droplet is dropped, figure 8(c) illustrates a state where the third ink droplet is dropped, figure 8(d) illustrates a state before the fourth droplet is dropped, and figure 8(e) illustrates a state after

the fourth droplet is dropped, respectively.

In figure 8, numeral 81 denotes an ink jet head having a nozzle 8 in a pressure chamber 82, numeral 82 denotes a pressure chamber filled in with ink supplied from an ink supply source (not shown), numeral 84 denotes a nozzle for discharging ink filling in the pressure chamber 82, numeral 85 denotes a pixel section, numeral 86 denotes a transparent substrate which is to be a color filter (hereinafter referred to as "color filter substrate"), numeral 87 denotes a frame formed by the black matrix, numeral 88a denotes a first ink droplet which is first discharged to the pixel section 85, numeral 88b denotes a second ink droplet which is secondly discharged to the pixel section 85, numeral 88c denotes a third ink droplet which is thirdly discharged to the pixel section 85, numeral 88d denotes a fourth ink droplet which is fourthly discharged to the pixel section 85, numerals 89a, 89b, 89c, and 89d denote the ink filling in the pixel section 85 after the ink droplets 88a, 88b, 88c, and 88d are spotted.

In figure 8(a), the ink jet head 81 is in a state where the pressure chamber 82 is filled in with ink, and the ink droplet is discharged from the

nozzle 84 toward the pixel section 85 of the color filter substrate 86.

When the ink droplet 88a is spotted on the surface of the color filter substrate 86 as shown in figure 8(b), it becomes the filling ink 89a spotted and spread between the frames 87. Then, the ink jet head 81 and the color filter substrate 86 are continuously relatively moved so that the ink droplet is not spotted on the same point, and in the order of figure 8(b) through figure 8(d), the second, third, and fourth ink droplets, 88b, 88c, and 88d are discharged from the ink jet head 81 and the frame 87 is filled in with the filling ink 89c. After a predetermined quantity of ink fills in the frame 87, the height of the filling ink 89d becomes higher than that of the frame 87, thereby producing a convex meniscus as shown in figure 8(d).

The method of pigmenting an accepting layer with ink comprises previously producing an ink accepting layer at pixel areas partitioned by black matrix film on the color filter substrate, discharging ink droplets toward this accepting layer by a similar method as that of directly pigmenting the color substrate, and making the spotted ink absorbed by the accepting layer over the whole pixel

area, thereby produce a color filter.

The conventional ink jet method is constructed as described above, and differently from the conventional method of producing a color filter by paint printing, chemical process, or the like, this method does not require repeating a similar process for each color, thereby resulting in neither lowered yield nor increased manufacturing cost due to repeated processing, and further, as well as it incurs no waste in filter material in manufacturing a color filter.

However, the method for manufacturing a color filter by the conventional ink jet method has following problems.

Hereinafter, the problems in the prior art will be described with reference to figures 8 and 9.

Figure 9 is a schematic diagram illustrating colored layers of the color filter manufactured by the conventional ink jet method. Figures 9(a) and 9(b) show cases where a color filter substrate is pigmented directly, and figure 9(c) shows a case where an accepting layer on the color filter substrate is pigmented, respectively.

In the figure, the same reference numeral as that shown in figure 8 denotes the same or

corresponding part, and numeral 90 denotes a decolorized part which is not filled in with ink in the pixel section, numerals 91a, 91b, 91c, and 91d denote a first ink dot, a second ink dot, a third ink dot, and a fourth ink dot, respectively, numeral 92 denotes an overlapping part of the ink dots, numeral 93 denotes a single ink droplet part, numeral 94 denotes a cross-boundary ink which goes beyond the frame 87, numerals 95a, 95b, 95c, 95d, 95e, 95f, 95g, 95h, and 95j denote colored layers, and numerals 99b and 99e denote filling ink of the colored layers 95b and 95e, respectively.

In this conventional ink jet method, when pigmenting a color filter substrate directly by filling in the frame 87 with a predetermined quantity of ink droplets from the ink jet head, because a large convex meniscus is produced in the frame 87 by the time the last ink droplet runs into the frame 87, waves are generated in the filling ink by the shock of the last ink droplet colliding, and spilt ink intrudes into neighboring frames beyond the frame, resulting in occurrence of color mixture.

Figure 9(a) illustrates a state where the ink 99b in an ink filling area goes beyond the frame 87 and intrudes into the colored layers 95a and 95c

adjacent to the original colored layer 95b. This color mixture is more likely to occur at a part where ink holding ability is deteriorated due to variations in the shape of the frame 87 or in the liquid repellency added to the frame 87.

Further, when there is a residue of a liquid-repellent material or the like on the surface of the color filter substrate at the colored parts partitioned by the frames, the filling ink 99e does not prevail uniformly over the corners of the pixel section as shown in figure 9(b), resulting in a large number of pixels each having decolorized part 90 therein. This is more likely to occur in the neighborhood of the spotting point of the last ink droplet or at the corners in the pixel section.

On the other hand, when the ink accepting layer on the color filter substrate is to be stained, the ink droplets are sequentially spotted on an accepting layer (not shown) at a constant time period with the ink spreading, and the ink dots 91a, 91b, 91c, and 91d are sequentially produced with the ink being absorbed into the accepting layer. Thereby, there are produced overlapping parts 92 and the single ink droplet parts 93 as shown in figure 9(c), thereby resulting in a color shade.

As described above, a color filter manufactured by the conventional ink jet method has problems in that the color concentration is not uniform due to that the color mixture, the decolorizing, the color shade of ink, or the like.

The present invention is made to solve the above-mentioned problems of the conventional one and has for its object to provide a color filter manufacturing method that can make uniform the color concentration of a color filter, as well as that can manufacture at low cost, and an ink jet head which realizes the color filter manufacturing method.

DISCLOSURE OF THE INVENTION

As described above, according to Claim 1 of the present invention, there is provided a color filter manufacturing method which, employing an ink jet head, discharges ink droplets to a pixel section of a color filter substrate to produce a colored layer of a color filter, and which discharges plural ink droplets to a pixel section at the same time. Therefore, when a color substrate is directly pigmented, the collision energy is consumed for spreading ink radially and the force making the ink go beyond the frame is suppressed, thereby

preventing color mixture and decolorizing of ink. When an accepting layer on the color filter substrate is pigmented, ink is absorbed into the accepting layer after respective ink dots are mixed, thereby preventing color shade. Consequently, in either case, it is possible to manufacture a color filter having uniform color concentration.

According to Claim 2 of the invention, there is provided an ink jet head which comprises: a nozzle plate in which a nozzle line composed of plural nozzles is formed; a flat plane plate which is provided with an actuator that is deformed by an electric signal; a pressure chamber being formed by a space surrounded by the nozzle plate and the flat plane plate; and the actuator applying pressure on ink supplied from an ink supply source to the pressure chamber, thereby to discharge ink droplets from the nozzles. Therefore, ink can be discharged at a small pitch at the same time without crosstalk generated, whereby a color filter having uniform color concentration can be manufactured.

According to Claim 3 of the invention, there is provided an ink jet head which comprises: a substrate of piezoelectric material in which a plurality of grooves deeper than the length of the

groove depth are formed so that they are parallel to one another; nozzle plates in which a plurality of nozzle lines composed of plural nozzles are formed at required sections parallel to one another; a cover plate which seals the deep grooves of the substrate of piezoelectric material; an actuator which provides an electric potential difference to partition walls of the deep grooves of the substrate of piezoelectric material to deform the partition walls in shear mode; plural pressure chambers being formed by spaces surrounded by the deep grooves of the substrate of piezoelectric material, the nozzle plates in which the nozzle lines are formed, the cover plate, and the actuator; plural air chambers which are deformed by the actuator being formed by spaces surrounded by the deep grooves of the substrate of piezoelectric material, the nozzle plates in which the nozzle lines are not formed, the cover plate, and the actuator; the pressure chambers and the air chambers being arranged alternately; and the actuator applying pressure on ink which fills in the plural pressure chambers from an ink supply source thereby to discharge ink droplets from the nozzles. Therefore, an interference when the plural pressure chambers are driven is decreased to

eliminate crosstalk, and ink droplets can be discharged at the same time and such that characteristics of ink droplets such as volumes and spotting speed should be uniform, whereby a color filter uniform in color concentration can be manufactured with a low cost equipment.

According to Claim 4 of the present invention there is provided an ink jet head which comprises: a substrate of piezoelectric material in which a plurality of grooves shallower than the length of the groove depth are formed so that they are parallel to one another; nozzle plates in which a plurality of nozzle lines composed of plural nozzles are formed in a line; a cover plate which seals the deep grooves of the substrate of piezoelectric material; an actuator which provides an electric potential difference to the substrate of piezoelectric material to deform the substrate of piezoelectric material in traverse distortion mode; a diaphragm which seals the shallow grooves of the substrate of piezoelectric material, and is displaced by the actuator; plural pressure chambers being formed by spaces surrounded by the shallow grooves of the substrate of piezoelectric material, the nozzle plates, and the diaphragm; and the

diaphragm being displaced applying pressure on ink which fills in the plural pressure chambers from an ink supply source, thereby to discharge ink droplets from the nozzles. Therefore, ink droplets can be discharged at the same time and such that characteristics of ink droplets such as volumes and spotting speed should be uniform, whereby a color filter uniform in color concentration can be manufactured with a low cost equipment.

According to Claim 5 of the invention, in the ink jet head as defined in any of Claims 2 to 4, in a case where a colored layer is produced on a pixel section whose shape is generally rectangular and whose ratio of lengths of a long side and a short side is threefold or more, the nozzle line has the nozzles provided parallel to a long-side direction of the pixel section and at regular nozzle intervals, the number of the nozzles being based on the shape of the pixel section. Therefore, spotted ink droplets are spread effectively in the pixel section, whereby an ink jet head which enables manufacturing of a color filter having uniform color concentration can be obtained.

According to Claim 6 of the present invention, in the ink jet head as defined in any of Claims 2 to

5, the nozzle line has nozzles which are located at its both ends provided at a distance of more than the length of short-side wall of the pressure chamber from the short-side walls. Therefore, uniform and high pressure is applied on ink filling in the pressure chamber by slight displacement of an actuator and the characteristics of ink droplets discharged such as volumes and spotting speed can be made all uniform, whereby an ink jet head which enables manufacturing of a color filter having uniform color concentration can be obtained.

According to Claim 7 of the invention, in the ink jet head as defined in Claim 3 or 4, the actuator has the partition walls or the substrate of piezoelectric material, signal electrodes, and common electrodes, and deforms all the partition walls or the substrate of piezoelectric material at the same time according to a first and a second signals applied to the signal electrodes and the common electrodes, respectively, and the electric potential difference therebetween. Therefore, the ink jet head can be compact, simplified, and low in cost, thereby obtaining an ink jet head which enables manufacturing of a color filter with a low-cost equipment.

According to Claim 8 of the invention, there is provided a color filter manufacturing method, which discharges plural ink droplets to a pixel section at the same time and such that the discharge characteristics of the respective ink droplets should be uniform, by the ink jet head as defined in any of Claims 2 to 7. Therefore, a color filter having uniform color concentration can be manufactured by an ink jet method.

BRIEF DESCRIPTION OF DRAWINGS

Figure 1 is a schematic diagram illustrating a color pattern of a color filter.

Figure 2 is a schematic diagram illustrating a color filter manufacturing method according to a first embodiment of the present invention, and figure 2(a) is a diagram showing the state immediately after ink discharging while figure 2(b) is a diagram showing the state after ink spotting.

Figure 3 is a schematic diagram of an ink jet head seen from an ink discharging direction, which has plural nozzles in a pressure chamber.

Figure 4 is a schematic diagram of an ink jet head seen from an ink discharging direction, which has plural pressure chambers and air chambers, and

utilizes shear mode deformation of piezoelectric ceramics.

Figure 5 is a schematic diagram illustrating a color filter manufacturing method according to a second embodiment of the present invention.

Figure 6 is a schematic diagram of an ink jet head seen from an ink discharging direction, which has plural pressure chambers and utilizes transverse distortion mode deformation of piezoelectric ceramics.

Figure 7 is a schematic diagram illustrating a color filter manufacturing method according to a third embodiment of the present invention.

Figure 8 is a schematic diagram illustrating a color filter manufacturing method by a conventional ink jet method which pigments a color filter substrate directly, and figure 8(a) is a diagram showing the state before spotting of a first ink, figure 8(b) is a diagram showing the state before spotting of a second ink droplet, figure 8(c) is a diagram showing the state before spotting of a third ink droplet, figure 8(d) is a diagram showing the state before spotting of a fourth ink droplet, and figure 8(e) is a diagram showing the state after spotting of the fourth ink droplet.

Figure 9 is a schematic diagram illustrating a colored layer of the color filter manufactured by the conventional ink jet method, and figure 9(a) is a diagram showing a case of pigmenting the color filter substrate directly, figure 9(b) is a diagram showing a case of pigmenting the color filter substrate directly, and figure 9(c) is a diagram showing a case of pigmenting an accepting layer on the color filter substrate.

BEST MODE TO EXECUTE THE INVENTION

(Embodiment 1)

A color filter manufacturing method according to a first embodiment of the present invention is one which employs an ink jet head that has plural nozzles in a single pressure chamber, and discharges plural ink droplets into a pixel section at the same time and such that characteristics of ink droplets such as volumes and spotting speed should be uniform, thereby to produce a colored layer of a color filter.

Figure 1 is a schematic diagram illustrating a color pattern of the colored filter manufactured by the color filter manufacturing method according to the first embodiment of the present invention.

In the figure, numeral 6 denotes a transparent

substrate which is to be a color filter (hereinafter referred to as color filter substrate), R denotes a red colored layer, G denotes a green colored layer, and B denotes a blue colored layer, and this color filter has a color pattern in which three colors are patterned in stripes. Further numeral 7 denotes a frame formed by black matrix.

There are following two methods for manufacturing the colored layers R, G, and B which employs an ink jet head.

First, a method of producing a colored layer directly employing ultraviolet curing ink including pigment and dye comprises filling in the frame 7 of black matrix having liquid repellency with ink by the ink jet head, and drying and solidifying the ink, thereby to produce a colored layer.

On the other hand, a method of employing ink mixed with color dye and a layer to be stained, which has an ink accepting layer provided on the black matrix formed into a grid pattern by sputtering and photolithography of chrome, comprises making ink accreted and absorbed into the accepting layer by the ink jet head, thereby to produce a colored layer.

A manufacturing method for producing a colored

layer by filling ink in the frame of black matrix will be described with reference to figure 2.

Figure 2 is a schematic diagram illustrating a color filter manufacturing method according to the first embodiment of the present invention, and figure 2(a) shows the state immediately after ink discharging while figure 2(b) shows the state after ink spotting, respectively.

In the figure, the same reference numerals as those shown in figure 1 denote the same or corresponding parts. Numeral 1 denotes an ink jet head which has plural nozzles 4 (4a through 4d in this example) in a single pressure chamber 2, numeral 2 denotes a pressure chamber to which ink is supplied from an ink supply source not shown and which applies pressure on ink that is to fill in the color filter substrate by an actuator, numeral 3 denotes a nozzle plate which is provided in front of the pressure chamber 2 and has a nozzle line 5 formed as well as seals the pressure chamber 2, numeral 4 denotes plural nozzles which discharge ink filling in the pressure chamber 2, numeral 5 denotes a nozzle line composed of plural nozzles 4a through 4d which are arranged in a line at regular intervals one another, numeral 7 denotes a frame formed by

black matrix, numeral 8 denotes ink droplets discharged from the plural nozzles 4a through 4d, numeral 9 denotes a pixel section partitioned by the frames 7, numeral 10 denotes a ink discharging direction, and numeral 11 denotes filling ink which forms a convex meniscus and which is formed with the ink droplets 8a through 8d discharged from the nozzles 4a through 4d at the same time.

Further, the position of ink discharging of the ink jet head 1 is the position where the center of the nozzle line 5 overlaps with the center of the pixel section 9, seen from the ink discharging direction 10.

Further, in a case where the shape of the pixel section 9 is generally rectangular, and the ratio of lengths of a long side and a short side is threefold or more, the number of the nozzles 4 provided in a single pressure chamber 2 is assumed to be an integer number approximate to the ratio of lengths of a long side and a short side of the pixel section 9. This is to make spotted ink droplets spread effectively in the pixel section.

Next, the operation will be described.

When the frame 7 on the color filter substrate 6 is moved to the discharging position of the ink

jet head 1, the ink jet head 1 has an ink discharging signal outputted to a drive circuit thereof from a movement control circuit not shown, and applies pressure on ink filling in the pressure chamber 2 by an actuator or the like according to the ink discharging signal, thereby discharging the ink droplets 8a, 8b, 8c, and 8d from the nozzles 4a, 4b, 4c, and 4d of the nozzle line 5 at the same time. The characteristics of these ink droplets 8a, 8b, 8c, and 8d such as volumes and spotting speed is nearly uniform, and the respective ink droplets collide with the surface of the substrate 6 of the pixel section (ink filling area) at different spotting points, are squashed in another moment, radiate out from the spotting points, and form ink dots of thinly columnar shape. Subsequently, the ink dot flows in the pixel section 9 losing dot shape, and becomes the filling ink 11 which forms a convex meniscus together with other ink dots.

In the experiment, when the ink droplet having 10-15cp of viscosity and 15-30pl of volume is collided with the pixel section 9 of the color filter substrate 6 at a spotting speed of 4-7m/s, the diameter of the ink dot is nearly 60-90 μ m. When types of the ink and the color filter are same, the

diameter of the ink dot is determined by the volume and the spotting speed of the ink droplet, whereby the optimum diameter of the ink dot can be selected from the size of the pixel section 9 and the quantity of the filling ink 11.

As described above, in this first embodiment, plural ink droplets 8 are spotted on the surface of the transparent substrate 6 at the same time, whereby respective ink dots are formed in the pixel section (ink filling area) 8 uniformly at the same time, and the ink is spread over the ink filling area due to interference forces of neighboring ink dots.

On the contrary, in a conventional ink filling method in which ink droplets are rushed in turn, the ink droplets are discharged by ones, and therefore, when the last ink droplet 8d is rushed into a convex meniscus in the ink filling area which is formed with the previously discharged ink droplets 8a, 8b, and 8c, big waves are generated on the meniscus, resulting in ink which is spilt over the frame 7 into neighboring pixels.

However, in the ink filling method according to the first embodiment, all the ink droplets 8a, 8b, 8c, and 8d collide with the surface of the color

filter substrate 6 at the same time, whereby energy is consumed for spreading ink of the respective ink droplets on the surface of the substrate 6, and the force of ink going beyond the frame 7 is suppressed.

Further, in the conventional method, ink may not permeate into the corners of the ink filling area close to the spotting position of the last ink droplet 8d, resulting in a decolorizing. This is because in a case where the filling ink of the previous ink droplets 8a through 8c fills in with the corners of the ink filling area left, even when the last ink droplet 8d rushes onto the filling ink, a pressure flows to the side of the filling ink, resulting in a difficulty of ink permeating into the corners.

Also in this case, in the method according to the first embodiment, the ink droplet 8d is spotted with other droplets 8a, 8b, and 8c all at once directly on the surface of the transparent substrate 6 in the neighborhood of the corners of the ink filling area therein which corresponds to the spotting point of the last ink droplet 8d in the conventional method, whereby ink permeates easily into the corners of the ink filling area by the force of ink being spread radially on the

transparent substrate after spotting.

Further, according to the first embodiment, also in a case of discharging ink droplets onto an accepting layer, plural ink droplets are spotted on the accepting layer uniformly at the same time, whereby they are absorbed after interference parts of neighboring ink dots on the accepting layer are mixed in a liquid state. Thereby, density unevenness at the overlapping parts of ink dots found in the conventional method is eliminated.

Next, the relation between the pressure chamber and the nozzles of the ink jet head according to the first embodiment will be described with reference to figure 3.

Figure 3 is a schematic diagram of the ink jet head seen from a ink discharging direction, which has plural nozzles in a single pressure chamber.

Here, a case where four nozzles are formed is shown. These nozzles are arranged in a line in accordance with the shape of the ink filling area of the color filter.

In the figure, the same reference numerals as those shown in figure 2 denote the same or corresponding parts. Numeral 12 denotes a long-side wall of the pressure chamber 2 which is provided

with an actuator not shown and composed of flat plane plates 14a and 14b, numeral 13 denotes a short-side wall of the pressure chamber 2 which is composed of flat plane plates 14c and 14d, L denotes a length inside the long-side wall 12 of the pressure chamber 2, W denotes a length inside the short-side wall 13 of the pressure chamber 2, and S denotes lengths from the center of the nozzles 4a and 4d located at both ends of the nozzle line 5 to the short-side wall 13.

These four nozzles 4a through 4d are provided in a single pressure chamber 2. The shape of the cross section of the pressure chamber 2 is a rectangle having the long-side wall 12 of axial length L of the nozzle line 5 and the short-side wall 13 of width W vertical to the length L. The spaces S from the short-side wall 13 to the center of the nozzles at the both ends of the nozzle line 5 consist of the lengths longer than the width W of the short-side wall 13. Further, the actuator not shown which is to apply pressure on ink in the pressure chamber 2 is provided at the long-side wall 12 of the cross section of the pressure chamber 2, and constructed to be displaced in a direction vertical to the long-side wall 12.

Here, the plural nozzles 4 are provided in the single pressure chamber 2 due to following process.

That is, a pixel pitch of a typical color filter is about $300\mu\text{m}$, and that for a liquid crystal panel of VGA (640×480 dots) of 10.4 inch is $330\mu\text{m}$, and that for a liquid crystal panel of SVGA (1024×1024 dots) of 18.1 inch is $280\mu\text{m}$, for example. While the number of the nozzles suited for this pixel section is four, it is very difficult to discharge ink at the same time by usual ink jet head 1 (for printing) with these four nozzles 4 arranged within $300\mu\text{m}$ at a pitch of $60\mu\text{m}$. This is because the minimum pitch in the piezo method is about $141\mu\text{m}$, and that in the bubble jet method is about $71\mu\text{m}$, for example, both exceeding $60\mu\text{m}$.

In addition, with such a head of close pitch, the distance to a neighboring channel is short, whereby so-called crosstalk, that is, pressure vibration at the discharging of ink inside a channel, affects the neighboring channel, and thus, there may occur a problem that the discharging performance when discharging droplets from the neighboring nozzle at the same time varies from the discharging performance when discharging droplets from a single nozzle, and therefore, in the ink jet head for

printing, discharging droplets from the neighboring channel at the same time is avoided, and a single nozzle is provided in a pressure chamber, as well as timings of discharge at individual nozzles of plural pressure chambers are staggered, thereby achieving the discharge of ink droplets from all the nozzles.

However, though the idea to provide a single nozzle in a pressure chamber is indispensable for printer application, it has no use for manufacturing a color filter. That is because, as described above, when ink droplets are discharged by ones, color shade or the like occur.

Consequently, it is conceived that the ink jet head 1 is specialized for manufacturing a color filter and the nozzles 4 which are arranged in the section are provided in the identical pressure chamber 2, thereby obtaining an ink jet head optimized for color filter manufacture which enables plural droplets to be discharged at the same time as well as the nozzles to be arranged at a close pitch.

However, in this ink jet head optimized for manufacturing a color filter, it is essential that the discharge characteristics at respective nozzles are uniform and the crosstalk is not generated in spite of close-pitch nozzles.

As a result of committed researches conducted by the inventor of this case, it is found that this can be realized with following construction.

First, a description will be given of the cross-section shape of the pressure chamber 2 of this ink jet head optimized for manufacturing a color filter.

In figure 3, it is available that the nozzle line 5 is put between plane parallel plates so that the plane parallel plate flow of ink is applied to all the nozzles in order to obtain the same discharge characteristics from any nozzles 4 of the nozzle line 5.

As the position of the short-side wall 13 as a side wall of the plane parallel plate, the distance S from the center of the nozzles at both ends 4a and 4d to the short-side wall 13 is more than the distance between the plane parallel plates, that is, the length of the short-side wall W so that the short-side wall 13 does not affect the flows of the nozzles at the both ends of the nozzle line 5. It is preferable that the short-side length W is more than double the nozzle diameter.

In order to apply pressure effectively on ink in the pressure chamber 2 of this shape, it is

preferable that the length S from the nozzles at both ends to the short-side wall is provided with more than the length W inside the short-side wall 13 so that flows of the ink discharged from the both ends 4a and 4d are not affected by the short-side wall 13, the nozzle line 5 is provided on the line parallel to the long-side wall 12 which passes through the center of the short-side wall 13, and the length W inside the short-side wall 13 is more than double the nozzle diameter.

Thereby, uniform and high pressure can be applied on ink with slight displacement of the long-side wall 12.

As described above, according to the first embodiment of the present invention, the plural ink droplets 8a, 8b, 8c, and 8d can be discharged onto the single pixel section 9 at the same time and such that the characteristics of the ink droplets such as volumes and spotting speed should be uniform, and therefore, when pigmenting the color filter substrate 6 directly, collision energy is consumed for spreading ink radially and the force to go beyond the frame 7 is suppressed, thereby preventing color mixture and decolorizing of ink. When pigmenting the accepting layer on the color filter

substrate 6, ink is absorbed into the accepting layer after respective ink dots are mixed, thereby preventing color shade. Consequently, in either case, it is possible to manufacture a color filter having uniform color concentration.

Further, according to the first embodiment of the present invention, the ink jet head 1 in which plural nozzles 4 are provided in the single pressure chamber 2 is employed, whereby ink can be discharged at a small pitch at the same time without crosstalk generated, whereby a color filter having uniform color concentration can be manufactured.

Further, according to the first embodiment of the present invention, the ink jet head 1 is employed which has the long-side wall 12 of the pressure chamber 2 provided with an actuator and composed of flat plane plates, and in which the lengths S from the nozzles at both ends to the short-side wall 13 are provided to be more than the length W inside the short-side wall 13, whereby uniform and high pressure is applied on ink filling in the pressure chamber 2 by slight displacement of the actuator and the characteristics of the ink droplets 8a, 8b, 8c, and 8d discharged such as volumes and spotting speed can be made all uniform,

whereby a color filter having uniform color concentration can be manufactured.

Further, according to the first embodiment of the present invention, in a case where the shape of the pixel section 9 is generally rectangular, and the ratio of lengths of a long side and a short side is threefold or more, the number of the plural nozzles 4 for the single pressure chamber 2 is assumed to be an integer number approximate to the ratio of lengths of a long side and a short side of the pixel section 9, and the ink jet head in which these nozzles 4 are arranged in a line at regular intervals is employed, whereby spotted ink droplets are spread effectively in the pixel section, resulting in a color filter having uniform color concentration.

(Embodiment 2)

A color filter manufacturing method according to a second embodiment of the present invention is one which employs an ink jet head having plural pressure chambers and air chambers provided, and utilizing shear mode deformation of piezoelectric ceramics, and discharges plural ink droplets into a plurality of same-color pixel sections existing in a short-side direction of the pixel section at the

same time and such that characteristics of ink droplets such as volumes and spotting speed should be uniform, thereby to produce a colored layer of a color filter.

Figure 4 is a schematic diagram of an ink jet head seen from an ink discharging direction, which is provided with plural pressure chambers and air chambers, and utilizes shear mode deformation of piezoelectric ceramics.

In the figure, numeral 41 denotes partition walls which separate pressure chambers 42 and air chambers 48. Numeral 42 denotes plural pressure chambers which are filled in with ink, and are composed of a nozzle plate, an actuator 100, a piezoelectric ceramics substrate 49, and a cover plate 50. Numeral 45 denotes nozzle lines which comprise plural nozzles arranged such that they are parallel to one another, numeral 46 denotes signal electrodes formed with metal film at a part corresponding to an upper half of the inner wall of the pressure chamber, numeral 47 denotes common electrodes formed with metal film at a part corresponding to an upper half of the inner wall of the pressure chamber, and numeral 48 denotes plural air chambers which air fills in, are composed of the

nozzle plate, the actuator, a piezoelectric ceramics substrate 49, and the cover plate 50, and has no nozzles. Numeral 49 denotes a piezoelectric ceramics substrate formed such that deep grooves which are to be the pressure chambers 42 and the air chambers 48 are parallel to one another, numeral 50 denotes the cover plate which is formed with a ceramics material, a resin material, or the like and seals openings of the deep grooves which are to be the pressure chambers 42 and the air chambers 48, numeral 52 denotes a polarization direction of the partition walls 41, V1 denotes an electric potential applied to the common electrodes 47, and V2 denotes an electric potential applied to the signal electrodes 46.

Further, numeral 100 denotes the actuator which comprises the partition walls 41, the signal electrodes 46, and the common electrodes 47, and the deep grooves of the piezoelectric ceramics substrate 49 are formed such that the pressure chambers 42 and the air chambers 48 are arranged at predetermined intervals.

The ink jet head shown in figure 4 comprises the piezoelectric ceramics substrate 49 polarized in the same direction as the polarization direction 52,

the cover plate 50, a nozzle plate not shown, and a driver substrate not shown. In the piezoelectric ceramics substrate 49, plural deep grooves are formed parallel at a same depth. At the partition wall 41 of the piezoelectric ceramics between the deep grooves which is polarized in the direction 52, metal film is formed only at an upper half, and is joined together at an end of the groove in a direction of depth and becomes a signal electrode 46 and a common electrode 47. Further, the pressure chambers 42 and the air chambers 48 of ink are formed alternately by these deep grooves. The air chamber 48 has no nozzles formed therein and is sealed with the cover plate 50 at the end of the groove, and the pressure chamber 42 communicates with an ink supply channel. The cover plate 50 is formed with a ceramics material, resin material, or the like, and is joined firmly to the piezoelectric ceramics substrate 49 by an epoxy adhesive. Further, a nozzle plate not shown having nozzle line 45 which is provided correspondingly to the pressure chamber 42 is joined to a front end face of the piezoelectric ceramics substrate 49 and the cover plate 50. The nozzle lines 45 have their array axes provided parallel in a direction of depth of the

deep grooves. The signal electrode 46 of the pressure chamber 42 and the common electrode 47 of the air chamber 48 are connected to a driver circuit not shown to which respective ones are connected in common.

The construction is such that when a voltage V_1 is applied to the common electrode 47 of the air chamber 48 and a voltage V_2 is applied to the signal electrode 46 of the pressure chamber 42 from the driver circuit to provide an electric potential difference between partition walls 41, the polarization direction 52 and an electric field direction run at right angles and an upper half of the partition wall 41 receives shearing force, and partition walls at the both sides of the pressure chamber 42 are displaced inwardly at the same time as shown by dotted lines in the figure, thereby pressurizing ink in the pressure chamber 42. In this case, droplets are discharged from the four nozzles of the nozzle line 45 at the same time.

That is, the partition wall 41 is polarized by the electric potential difference of V_1 and V_2 , and the polarization direction and the electric field direction run at right angles, whereby the partition wall 41 receives the shearing force at its upper

half. By the sharing force, the partition wall 41 of the pressure chamber 42 are deformed inwardly at the same time as shown by the dotted line in figure 4 to pressurize ink which fills in the pressure chamber 42, whereby the partition wall 41 of the air chamber 48 is deformed outwardly. The ink pressurized by the partition wall 41 is discharged respectively from the nozzle line 45 at the same time to pigment a large number of same-color pixel sections which are in a line vertical to a direction of movement of the color filter substrate.

Here, the air chamber 48 is provided to eliminate the effect of the crosstalk generated by an interference when the pressure chamber 42 adjoining each other is driven, and this is available for that ink droplets are discharged and spotted to the frame of the pixel section stably at a exact position in a precise quantities.

That is, with a head of piezo method shear mode type, ink discharge is performed from all the neighboring channels conventionally, and this is an available method to reduce the nozzle pitch and is effective for a printer head which aims at speeding up; however, there is a defect that the crosstalk cannot be avoided since a pressure vibration is

given to other channels through channel side walls and ink in a neighboring channel.

On the contrary, in a second embodiment of the present invention, nozzles are eliminated in a neighboring channel adjoining to an ink discharge channel to make the channel an airspace, making account of a high-precision control of an ink discharge quantity so as to optimize for manufacturing a color filter of relatively low resolution.

Thereby, a pressure vibration conventionally generated through ink in a neighboring channel can be avoided, resulting in a high-precision and highly stable ink discharge which is free of crosstalk.

This is due to that propagation of a pressure vibration through an airspace is not generated since the elastic modulus of air is considerably low as compared with ink.

Also in a case where these air chambers 48 are provided, it is possible enough to match a pitch of the pressure chamber 42 with a pixel pitch of a particular color of a color filter. In addition, by that this air chamber 48 is provided, a large number of pressure chambers 42 can be driven only by two types of signals V1 and V2, thereby simplifying a

driver circuit and contributing to a cost down of the whole.

That is, with a conventional head of piezo method shear mode type in which nozzles are provided in all the successive channels, and which enables ink discharges from the respective nozzles, it is required to provide V1 and V2 to channels according to discharge patterns in the manner in which a signal V1 (negative pressure: ink filling) is provided to an ink discharge channel and a signal V2 (application of pressure: ink discharge) is subsequently provided to a neighboring channel, thereby completing a discharge of one drop, and next, when discharging ink from the channel to which the signal has just provided, the signal V1 is provided to the channel and the signal V2 is subsequently provided to the neighboring channel; therefore, the driver circuit is complicated.

On the contrary, with the construction according to the second embodiment, in which airspaces are provided at both sides of the ink discharge channel, the signal V1 is provided to the ink discharge channel and the signal V2 is provided to the airspaces at the both sides exclusively.

In a case where a nozzle pitch of a head which

has airspaces is made in accordance with a pixel pitch of a color filter, a pixel array axis of the color filter and a nozzle array axis of the head can be made parallel, and therefore, a delay processing of a driving signal required when the head is sloped is not needed and it is possible to provide a wiring in which all the nozzles discharge at the same time, thereby simplifying a driver circuit.

Therefore, it is possible to fan out the signal V1 to a large number of discharge channels and the signal V2 to a large number of airspace channels.

Figure 5 is a schematic diagram illustrating a color filter manufacturing method according to the second embodiment of the present invention.

In the figure, the same reference numeral as that shown in figure 4 denotes the same or corresponding part. Numeral 51 denotes an ink jet head which has a plurality of pressure chambers and air chambers 48, and utilizes shear mode deformation of a piezoelectric ceramic, numeral 53 denotes a direction of movement of a color filter substrate, and P1 denotes an interval between same-color pixel sections in a direction of short-side of the pixel section. Further, the pressure chamber 42, the air chamber 48, and the nozzle line 45 are arranged to

keep this interval P1.

Next, the manufacturing method will be described. The ink jet head 51 which has a pressure chamber of the same pitch as the pitch P1 of a particular color of the pixel section R, G, or B formed on a color filter substrate 56 and a nozzle line provided vertically to an array direction of the pressure chamber, and the color filter substrate 56 are arranged in such a physical relationship as described in figure 5, and the substrate 56 is moved in a direction of the arrow 53 and droplets are sequentially spotted onto the pixel section which comes to a discharge position of the head, whereby ink fills in. A color filter is manufactured with a manufacturing device which performs such manufacturing operation.

As described above, in the second embodiment of the present invention, the ink jet head 51 is employed which utilizes shear mode deformation of piezoelectric ceramics and has a plurality of the pressure chambers 42 and the air chambers 48 provided therein, and thus, an interference when the plural pressure chambers 42 being driven is decreased to eliminate crosstalk, and ink droplets can be discharged at the same time and such that

characteristics of ink droplets such as volumes and spotting speed should be uniform, whereby a color filter uniform in color concentration can be manufactured with a low cost equipment.

Further, in the second embodiment of the present invention, the actuator provided in the pressure chamber 42 and the air chamber 48 is driven by two types of electrodes comprising the signal electrode 46 and the common electrode 47, and therefore, the ink jet head 51 can be compact, simplified, and low in cost, thereby manufacturing a color filter with a low-cost equipment.

(Embodiment 3)

A color filter manufacturing method according to a third embodiment of the present invention is one which employs an ink jet head having plural pressure chambers provided, and utilizing transverse distortion mode deformation of piezoelectric ceramics, and discharges plural ink droplets into a plurality of same-color pixel sections existing in a long-side direction of the pixel section at the same time and such that characteristics of ink droplets such as volumes and spotting speed should be uniform, thereby to produce a colored layer of a color filter.

Figure 6 is a schematic diagram of an ink jet

head seen from an ink discharging direction, which has plural pressure chambers and utilizes transverse distortion mode deformation of piezoelectric ceramics.

In the figure, numeral 62 denotes plural pressure chambers filled in with ink, which comprise a nozzle plate, a piezoelectric ceramics substrate 69, and a diaphragm 70. Numeral 64 denotes a piezoelectric ceramics plate which is deformed in transverse distortion mode, numeral 65 denotes a nozzle line which is arranged in a line on the nozzle plate and comprises plural nozzles, numeral 66 denotes a signal electrode, numeral 67 denotes a common electrode, numeral 69 denotes the piezoelectric ceramics substrate in which grooves shallower than the length of groove depth are formed so that they are parallel to one another, numeral 70 denotes the diaphragm which seals openings of the shallow grooves of the piezoelectric ceramics substrate 69, V1 denotes an electric potential applied to the common electrode 67, and V2 denotes an electric potential applied to the signal electrode 66. Numeral 110 denotes an actuator, which comprises the piezoelectric ceramics substrate 64, the signal electrode 66, and the common

electrode 67.

The ink jet head described here comprises the pressure chambers 62, the diaphragm 70, and the piezoelectric ceramics plate 64. The pressure chamber 62 is constructed in the manner in which the openings of the shallow grooves formed on the front end face of the ceramics substrate 69 by molding or cutting are sealed with the diaphragm 70. The actuator 110 comprises the piezoelectric ceramics plate 64 joined to the top surface of the diaphragm 70 correspondingly to the pressure chamber 62, the common electrode 67 on the top surface of the diaphragm 70, and the signal electrode 66 on the top surface of the piezoelectric ceramics plate 64. The piezoelectric ceramics plate 64 is subjected to poling process by applying high voltage to the common electrode 67 and the signal electrode 66. When an electric potential difference of driving level is provided between the common electrode 67 and the signal electrode 66 which have so-polarized piezoelectric ceramics plate 64 in between, an electric field parallel to a polarization direction is applied and a transverse distortion of the piezoelectric ceramics plate 64 is generated so as to contract in a direction of plate surface. A

bending stress is applied to the diaphragm 70 by the contraction of the piezoelectric ceramics plate 64, and the diaphragm 70 is displaced in an inward direction of the pressure chamber 62. The nozzle plate not shown is joined to the front surface of the pressure chamber 62, and the nozzle line 65 is provided correspondingly to the position of the pressure chamber 62. The nozzle array axis of the nozzle line 65 is provided parallel to the joint member of the diaphragm 70 and the piezoelectric ceramics plate 64, that is, the plate surface of the actuator. As described above, the shallow grooves are formed in the ceramics substrate 69 and the top wall of the substrate which corresponds to the long-side wall of the pressure chamber 62 is made into an actuator, whereby an ink jet head suited for the present invention can be manufactured also in the case of traverse distortion mode.

The piezoelectric ceramics plate 64 is polarizes by the electric potential difference between V_1 and V_2 , and traverse distortion is generated when the polarization direction is parallel to the electric field. The diaphragm 70 is applied the bending stress by the traverse distortion of the piezoelectric ceramics plate 64,

and is deformed inwardly to the pressure chamber 62 as shown by dotted line in figure 6. The pressure chamber 62 pressurize the filling ink by the deformation of the diaphragm 70 and makes the ink droplets discharged from the nozzle line 65 at the same time, so as to pigment a plurality of same-color pixel sections which are in a line vertical to a direction of movement of the color filter substrate.

Figure 7 is a schematic diagram illustrating a color filter manufacturing method according to the third embodiment of the present invention.

In the figure, the same reference numeral as that shown in figure 6 denotes the same or corresponding part. Numeral 71 denotes an ink jet head which has a plurality of pressure chambers, and utilizes traverse distortion mode deformation of a piezoelectric ceramic, numeral 73 denotes a direction of movement of a color filter substrate, and P2 denotes an interval between pixel sections adjoining in a direction of long-side of the pixel section. Further, the pressure chamber 62 and the nozzle line 65 are arranged to keep this interval P2.

Next, the manufacturing method will be described.

The ink jet head 71 which has a pressure chamber of the same pitch as the pitch P2 of a particular color of the pixel section R, G, or B formed on a color filter substrate 76 and a nozzle line 65 provided parallel to an array direction of the pressure chamber, and the color filter substrate 76 are arranged in such a physical relationship as described in figure 7, and the substrate 76 is moved in a direction of the arrow 73 and droplets are sequentially spotted onto the pixel section which comes to a discharge position of the head to fill in. A color filter is manufactured with a manufacturing device which performs such manufacturing operation.

As described above, in the third embodiment of the present invention, the ink jet head 71 is employed which utilizes traverse distortion mode deformation of piezoelectric ceramics and has a plurality of the pressure chambers 62 provided therein, and thus, ink droplets can be discharged at the same time and such that characteristics of ink droplets such as volumes and spotting speed should be uniform, whereby a color filter uniform in color concentration can be manufactured with a low cost equipment.

Further, while in any of the above-described

embodiments 1 to 3, a case of manufacturing a color filter such as a liquid crystal display panel is described, the present invention is not restricted to this, and any ones in which ink is spotted and fills in cells such as concave portions and sections are applicable.

APPLICABILITY IN INDUSTRY

As described above, a color filter manufacturing method and an ink jet head according to the present invention is suited to discharge ink droplets onto a color filter substrate of a liquid crystal display so as to manufacture a color filter of uniform color concentration at low cost.



CLAIMS

1. A color filter manufacturing method which,
employing an
ink jet head, discharges ink droplets to a pixel
section of a color filter substrate to produce a
colored layer of a color filter, and which
discharges plural ink droplets to a pixel section at
the same time.
2. An ink jet head comprising:
a nozzle plate in which a nozzle line composed
of plural
nozzles is formed;
a flat plane plate which is provided with an
actuator that is deformed by an electric signal;
a pressure chamber being formed by a space
surrounded by the nozzle plate and the flat plane
plate; and
the actuator applying pressure on ink supplied
from an ink supply source to the pressure chamber,
thereby to discharge ink droplets from the nozzles.
3. An ink jet head comprising:
a substrate of piezoelectric material in which
a plurality of grooves deeper than the length of the
groove depth are formed so that they are parallel to



one another;

nozzle plates in which a plurality of nozzle lines composed of plural nozzles are formed at required sections parallel to one another;

a cover plate which seals the deep grooves of the substrate of piezoelectric material;

an actuator which provides an electric potential difference to partition walls of the deep grooves of the substrate of piezoelectric material to deform the partition walls in shear mode;

plural pressure chambers being formed by spaces surrounded by the deep grooves of the substrate of piezoelectric material, the nozzle plates in which the nozzle lines are formed, the cover plate, and the actuator;

plural air chambers which are deformed by the actuator being formed by spaces surrounded by the deep grooves of the substrate of piezoelectric material, the nozzle plates in which the nozzle lines are not formed, the cover plate, and the actuator;

the pressure chamber and the air chamber being arranged alternately; and

the actuator applying pressure on ink which fills in the plural pressure chambers from an ink



supply source, thereby to discharge ink droplets from the nozzles.

4. An ink jet head comprising:

a substrate of piezoelectric material in which a plurality of grooves shallower than the length of the groove depth are formed so that they are parallel to one another;

nozzle plates in which a plurality of nozzle lines composed of plural nozzles are formed in a line;

a cover plate which seals the deep grooves of the substrate of piezoelectric material;

an actuator which provides an electric potential difference to the substrate of piezoelectric material to deform the substrate of piezoelectric material in traverse distortion mode;

a diaphragm which seals the shallow grooves of the substrate of piezoelectric material, and is displaced by the actuator;

plural pressure chambers being formed by spaces surrounded by the shallow grooves of the substrate of piezoelectric material, the nozzle plates, and the diaphragm; and

the diaphragm being displaced applying pressure on ink which fills in the plural pressure chambers



from an ink supply source, thereby to discharge ink droplets from the nozzles.

5. The ink jet head as defined in any of Claims 2 to 4, wherein in a case where a colored layer is produced on a pixel section whose shape is generally rectangular and whose ratio of lengths of a long side and a short side is threefold or more,

the nozzle line has the nozzles provided parallel to a long-side direction of the pixel section and at regular nozzle intervals, the number of the nozzles being based on the shape of the pixel section.

6. The ink jet head as defined in any of Claims 2 to 5, wherein the nozzle line has nozzles which are located at its both ends provided at a distance of more than the length of short-side wall of the pressure chamber from the short-side walls.

7. The ink jet head as defined in Claim 3 or 4, wherein the actuator has the partition walls or the substrate of piezoelectric material, signal electrodes, and common electrodes, and deforms all the partition walls or the substrate of piezoelectric material at the same time according to a first and a second signals applied to the signal electrodes and the common electrodes, respectively,



and the electric potential difference therebetween.

8. A color filter manufacturing method, which discharges plural ink droplets to a pixel section at the same time and such that the discharge characteristics of the respective ink droplets should be uniform, by the ink jet head as defined in any of Claims 2 to 7.