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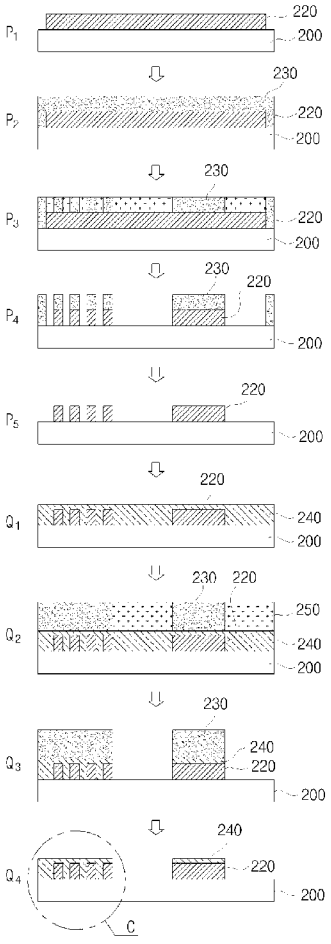
[Continued on next page]

(54) Title: HALF TONE MASK HAVING MULTI HALF PERMEATION PART AND MANUFACTURING METHOD OF THE SAME

[Fig. 5]



(57) Abstract: A half tone mask is characterized in that the half tone mask having at least one or more half permeation parts capable of adjusting a transmittance by adjusting pattern density of a fine pattern forming the half permeation part, whereby a pattern density of a fine pattern can be adjusted to enhance the efficiency of adjusting the transmittance in a half tone mask formed with a slit type half permeation part, a stacked type half permeation part or a combination thereof, and the transmittance of the half permeation region can be accurately controlled through adjustment of the pattern density without recourse to a separate manufacturing process.

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Description

Title of Invention: HALF TONE MASK HAVING MULTI HALF PERMEATION PART AND MANUFACTURING METHOD OF THE SAME

Technical Field

[1] The present invention relates to a half tone mask formed with a translucent region using a slit type or a stacked type half permeation part or a combination thereof, wherein a pattern density of a fine pattern is adjusted to enhance an efficiency of transmittance adjustment.

Background Art

[2] The conventional photo-mask used in patterning by way of photolithography process includes, as illustrated in FIG.1, a transparent substrate (1), a light transmission part (3) formed on the transparent substrate (1) capable of completely transmitting light, a light blocking part (2) capable of completely blocking light, and a half permeation part (16) having a half tone layer capable of partially transmitting light.

[3]

[4] The conventional mask can only be used in one cycle of photolithography process formed by an exposure-development -etching because the conventional mask can only implement one layer of pattern.

[5]

[6] To be more specific, TFT (Thin Film Transistor) and CF (Color Filter) are deposited / coated with lots of layers, and each deposited/coated layer is patterned by photolithography process. Meanwhile, there may be a great economic effect, if it is possible to reduce even one cycle in photolithography process. However, the conventional mask is non-economical because it is configured to implement only one layer of pattern. Furthermore, several tones must be implemented to form a multi half permeation part to create problems of prolonging processes and delivery time.

Disclosure of Invention

Technical Problem

[7] Meanwhile, as illustrated in FIG.2, a different type of photo-mask known as a gray tone mask was developed that includes a transmissive part (13) formed on a transparent substrate (11) for completely transmitting light, a light blocking layer (12) for completely blocking light, and a slit pattern (14) transmitting light by reducing an amount of irradiated light.

[8]

[9] However, the gray tone mask has a limit in the amount of adjustable transmissive light due to restriction in implementing a slit pattern, because the gray tone mask employs the diffraction of light that passes a fine pattern to adjust the amount of light.

[10]

[11] The gray tone mask is further disadvantageous in that an equal patterning cannot be implemented if the gray mask has a size greater than a predetermined one. The gray tone mask is still further disadvantageous in that exposure is hardly controllable in implementing the multi half permeation part to a slit type, because the gray tone mask uses the diffraction of light.

Solution to Problem

[12] The present invention is disclosed to obviate the above-mentioned disadvantages, and it is an object of the present invention to provide a half tone mask formed with a translucent region using a slit type or a stacked type half permeation part or a combination thereof, wherein a pattern density of a fine pattern is adjusted to enhance an efficiency of transmittance adjustment.

[13]

[14] It is another object to provide a multi half tone mask filled with a half permeation material in a discrete space of a slit type half permeation part to create a structure capable of controlling 3 or more mutually different transmittances.

[15]

[16] In one general aspect of the present invention, there is provided a half tone mask having at least one or more half permeation parts, capable of adjusting a transmittance by adjusting pattern density of a fine pattern forming the half permeation part.

[17]

[18] In some exemplary embodiments, the half permeation part in the half tone mask may have a structure forming a fine pattern on a half permeation film, a structure forming a fine pattern on a light blocking layer and formed with a half permeation film thereon, or a combined structure thereof.

[19]

[20] In some exemplary embodiments, the half permeation film may employ a half permeation material having a transmittance in the range of 4 ~75%.

[21]

[22] In some exemplary embodiments, a line width of the fine pattern may be adjusted in the range of 0.1μm ~1.3μm.

[23]

[24] In some exemplary embodiments, the half permeation material may be a material having as a main element one of Cr, Si, Mo, Ta, Ti, Al or a combined material mixed

with at least the two or more elements, or a material added with at least one of Cox, Ox, Nx to the main element material or the combined material.

[25]

[26] In another general aspect of the present invention, there is provided a manufacturing method of a half tone mask having a multi half permeation part, wherein the half tone mask includes a fine pattern adjusting an optical transmittance, and wherein a pattern density of the fine pattern is adjusted, and the optical transmittance is adjusted by adjusting a line width of the fine pattern in the range of 0.1μm ~1.3μm.

[27]

[28] In still another general aspect of the present invention, there is provided a half tone mask including a light transmissive part, a light blocking part and a half permeation part that are formed on a transparent substrate, wherein the half permeation part includes a multi half tone part filled with a half tone material in slits.

[29]

[30] In some exemplary embodiments, the half permeation part may include at least one or more multi half tone parts, wherein the half permeation part may further include at least one of a single half tone part formed with a half permeation material layer or a slit type half tone part formed with slits only.

[31]

[32] In some exemplary embodiments, the multi half tone part may include a slit type light blocking wall having a predetermined discrete space, wherein a half permeation material layer may be formed at a discrete space between the slit type light blocking wall and the light blocking part.

[33]

[34] In some exemplary embodiments, a half permeation material layer may be formed on the slit type light blocking wall and the light blocking part.

[35]

[36] In some exemplary embodiments, the half permeation material layer may be a combined material having Mo, Si, Ta, W, Al, Cr, Hf, Zr, Me, V, Ni, Nb, Co, and Ti as main elements, and combined with the at least two or more main element materials or main elements, or a material added with at least one of Cox, Ox and Nx to the main elements or to combined material, where x is a natural number.

[37]

[38] A half tone mask having the aforementioned structure according to the present invention may be manufactured by the following manufacturing method.

[39]

[40] In still further aspect of the present invention, there is provided a manufacturing method of half tone mask, characterized by: coating a photo-resist on a transparent

substrate stacked with a light blocking layer (first step); patterning by exposing and developing the photo-resist (second step); forming a slit type light blocking wall and a light permeation part by etching the light blocking layer (third step); and forming a multi half tone part by stacking a half permeation material layer in the slit type light blocking wall (fourth step).

[41]

[42] In some exemplary embodiments, the fourth step is characterized by: stacking a half permeation material layer on an upper surface of the light blocking layer (a 1); patterning by coating the photo-resist on the half permeation material layer (a 2); and selectively removing the half permeation material layer filled in a light transmissive part or the slit type light blocking wall through the patterned portion (a 3).

[43]

[44] In some exemplary embodiments, a step of removing the photo-resist following the etching of the light blocking layer or the half permeation material layer may be further included, subsequent to the third step and the fourth step.

[45]

Advantageous Effects of Invention

[46] The present invention is advantageous in that a pattern density of a fine pattern can be adjusted to enhance the efficiency of adjusting the transmittance in a half tone mask formed with a slit type half permeation part, a stacked type half permeation part or a combination thereof.

[47]

[48] There is another advantage in that the transmittance of the half permeation region can be accurately controlled through adjustment of the pattern density without recourse to a separate manufacturing process.

[49]

[50] There is still another advantage in that a multi half tone mask filled with a half permeation material in a discrete space of a slit type half permeation part to create a structure capable of controlling 3 or more mutually different transmittances.

[51]

[52] There is still further advantage in that a high quality multi half tone mask can be provided by transmittance controlled through diffraction phenomenon in slit and through a half permeation material layer to greatly enhance degrees of design freedom and degrees of correction freedom in transmittance with regard to defects, contributing to an improved process yield, a shortened process period and an enhanced product quality after exposure.

Brief Description of Drawings

[53] FIGS. 1 and 2 are conceptual drawings illustrating a half tone mask and a gray tone mask according to prior art.

[54] FIGS. 3 and 4 are conceptual drawings explaining a principle of an optical transmittance adjustment according to fine pattern.

[55] FIG. 5 is a process flowchart for manufacturing an exemplary embodiment of the present invention.

[56] FIGS.6 and 7 are graphs quantitatively illustrating a transmittance change according to pattern density adjustment of a half tone mask manufactured by the process in FIG.5.

[57] FIGS. 7 and 8 are flowchart and process chart illustrating a manufacturing process of a half tone mask according to another exemplary embodiment of the present invention.

[58] FIG. 10 is a schematic view illustrating essential parts of a multi half tone mask according to another exemplary embodiment of the present invention.

Best Mode for Carrying out the Invention

[59] Configuration and operation of the present invention will be described in detail with reference to the accompanying drawings.

[60]

[61] (First Exemplary Embodiment)

[62] The gist of the present invention is to provide a half tone mask formed with a half permeation region by disposing a fine pattern, capable of adjusting an accurate optical transmittance by adjusting a pattern density of fine pattern.

[63]

[64] Referring to FIG.3, a basic principle of adjusting transmittance of a half tone mask is explained.

[65]

[66] The half tone mask includes a half permeation layer (210) formed on a substrate (200), and a light blocking layer (220) completely blocking the light. The half permeation layer (210) may be implemented by forming fine patterns on a light blocking layer, or forming a light blocking layer on a half permeation film. The illustrated half permeation layer shows 2 half permeation regions (A, B) in which the optical transmittance is adjusted.

[67]

[68] Referring to FIG.4 in which the half permeation region (A) is enlarged, fine patterns having a predetermined line width (X1, X2, X3 .Xn) on a blocking layer or a half permeation layer (210) on a substrate are formed with spaces (S1, S2, S3 ..Sn). In a case exposure is performed through the half tone mask, the photo-sensitive material (PR) is changed, as shown, in shape after development due to changed optical trans-

mittance. Particularly, adjustment of width of fine pattern serves as an important factor of transmittance adjustment. The fine pattern density is a ratio occupied by the fine pattern per unit area, and a value calculated from a sum of the plurality of line widths (X1, X2, X3 .Xn) based on a ratio per entire unit area in the figure, where the pattern density is in inverse proportion to the optical transmittance.

[69]

[70] FIG. 5 is a process flowchart for manufacturing an exemplary embodiment of the present invention.

[71]

[72] First of all, in order to form a half tone mask having a structure shown in FIG.3, the substrate (200) is filmed with the light blocking material (220), on which a photo-resist (230) is coated. Then, an exposure process (P3), a development/ etching (P4) and an exfoliating/cleaning process (P5) are included, through which the conventional half tone mask formed with fine patterns can be manufactured.

[73]

[74] Particularly, it is preferable in forming the fine patterns in the present invention that a line width of the fine patterns be changed in the range of 0.1μm ~1.3μm. More preferably, the half permeation region formed with the fine patterns is coated with a half permeation film (240). The half permeation film may be used as a chrome-oxide film, and the half permeation material may be a material having as a main element one of Cr, Si, Mo, Ta, Ti, Al or a combined material mixed with at least the two or more elements, or a material added with at least one of Cox, Ox, Nx to the main element material or the combined material.

[75]

[76] To be more specific, a composition of stacked half permeation region may be any composition as long as it can transmit only part of light in a predetermined waveband. For example, the stacked half permeation region may be a composition of any one from a group of Cr_xO_y, Cr_xCO_y, $Cr_xO_yN_z$, Si_xO_y, $Si_xO_yN_z$, Si_xCO_y, $Si_xCO_yN_z$, Mo_xSi_y, Mo_xO_y, $Mo_xO_yN_z$, Mo_xCO_y, $Mo_xO_yN_z$, $Mo_xSi_yO_z$, $Mo_xSi_yO_zN$ $Mo_xSi_yCO_zN$, $Mo_xSi_yCO_z$, Ta_xO_y, $Ta_xO_yN_z$, Ta_xCO_y, $Ta_xO_yN_z$, Al_xO_y, Al_xCO_y, $Al_xO_yN_z$, $Al_xCO_yN_z$, Ti_xO_y, $Ti_xO_yN_z$, Ti_xCO_y, or a combination thereof, where the suffix x, y and z is a natural number and defines the number of each chemical element.

[77]

[78] Successively, an upper surface of the half permeation film (240) may be coated again with photo-resist (250), patterned, exposed, developed, etched (Q1~Q3), and the photo-resist is exfoliated to form the half tone mask of the present invention. (Q4).

[79]

[80] Now, referring to FIG.6, the features of the half tone mask by the transmittance ad-

justment obtained through the processes of FIG.5 according to the present invention will be described.

[81]

[82] FIG.6 illustrates a graph in which the half permeation film coated on the fine patterns has a 50% transmittance, and the light blocking material forming the light blocking layer is Cr, where transmittance change for each pattern density is shown. As illustrated, it can be noted that as the pattern density increases in the formal ratio, the optical transmittance decreases.

[83]

[84] In order to adjust the pattern density, the line width of the fine pattern is changed or adjusted in the range of 0.1μm ~1.3μm, where a difference of line width of 0.1μm can quantitatively change the optical transmittance by 14%. The changed transmittance may be summarized in the qualitative change as shown in FIG.7.

[85]

[86] The present invention through the quantitatively changed line width of fine patterns thus described can easily change the transmittance, which can not only derive the quantitative line width change but also reduce the manufacturing processes greatly. The present invention also has an advantage of reducing the defect rate to thereby increase the production yield.

[87]

[88] (Second Exemplary Embodiment)

[89]

[90] The gist of the present invention is to provide a photo-mask structure having a multi half tone part where a half permeation material is filled in discrete spaces of slit type half permeation part.

[91]

[92] FIGS. 8 and 9 are flowchart and process chart illustrating a manufacturing process of a photo-mask according to another exemplary embodiment of the present invention.

[93]

[94] Now, an exemplary embodiment of photo-mask structure implemented by the manufacturing method according to the present invention will be described with reference to the process chart.

[95]

[96] Referring to FIGS.8 and 9, a manufacturing method of photo-mask may be characterized by: coating a photo-resist on a transparent substrate stacked with a light blocking layer (first step); patterning by exposing and developing the photo-resist (second step); forming a slit type light blocking wall and a light permeation part by etching the light blocking layer (third step); and forming a multi half tone part by

stacking a half permeation material layer in the slit type light blocking wall (fourth step).

[97]

[98] To be more specific, in first step (S1), the manufacturing method may include forming a blank mask in which a transparent substrate (110) is filmed with a light blocking layer (120). The material forming the light blocking layer may be any material as long as it blocks the light, but preferably, any one of Cr and CrxOy or a combination of both, where x and y is a natural number that changes according to combination of elements.

[99]

[100] Successively, in second step (S2), photo-resist (130) is coated, which is then exposed, developed and patterned to a predetermined pattern. A light blocking layer (120) is etched via a patterned pattern (131) to form a half permeation part (123) formed with a light transmissive part (122) and a slit type light blocking wall (121).

[101]

[102] Thereafter, a half permeation material (141) may be filled in the slit type light blocking walls (121) to form a multi half tone part (H) (S41).

[103]

[104] That is, the multi half tone part (H) according to the present invention has a structure where the half permeation material is filled in the slit type light blocking walls.

[105]

[106] The half permeation material may be preferably a material having as a main element one of Mo, Si, Ta, W, Al, Cr, Hf, Zr, Me, V, Ni, Nb, Co and Ti, or may be a combined material mixed with at least the two or more elements, or may be a material added with at least one of Cox, Ox and Nx to the single main element material or the combined materials. The half permeation material may be a composition of any one from a group of Cr_xO_y, Cr_xCO_y, $Cr_xO_yN_z$, Si_xO_y, $Si_xO_yN_z$, Si_xCO_y, $Si_xCO_yN_z$, Mo_xSi_y, Mo_xO_y, $Mo_xO_yN_z$, Mo_xCO_y, $Mo_xO_yN_z$, $Mo_xSi_yO_z$, $Mo_xSi_yO_zN$ $Mo_xSi_yCO_zN$, $Mo_xSi_yCO_z$, Ta_xO_y, $Ta_xO_yN_z$, Ta_xCO_y, $Ta_xO_yN_z$, Al_xO_y, Al_xCO_y, $Al_xO_yN_z$, $Al_xCO_yN_z$, Ti_xO_y, $Ti_xO_yN_z$, Ti_xCO_y, or a combination thereof, where the suffix x, y and z is a natural number and defines the number of each chemical element.

[107]

[108] Hereinafter, there will be a description on the fourth step (S4) in which a process of forming 3 or more half permeation part including the multi half tone part (H) will be explained.

[109]

[110] To be more specific, although the method of forming the multi half tone part may be variably applied by using the process of filling the half permeation material in the slit

type light blocking walls (121) of third step (S3), the present exemplary embodiment will introduce a process of implementing multi half permeation parts each having a different transmittance using a single process and using photo-resist.

[111]

[112] First, an upper surface of the light blocking layer formed in the third step (S3) is coated with a half permeation material layer (140) (S41), and a photo-resist (150) is then coated on an upper surface of the half permeation material layer (140).

[113]

[114] A selective patterning is performed on a region having a variable transmittance (S43), a selective etching is performed on the half permeation material layer via the patterned pattern, the photo-resist is removed and a light transmissive part (W) is formed on a region where the transparent substrate is exposed to implement a photo-mask formed with a slit type half tone part (Z) formed only with the slit type light blocking walls, a single half tone part (Y) formed with a half tone material film and a multi half tone part (X) formed with the slit type light blocking wall and the half permeation material (S44).

[115]

[116] FIG. 10 is a schematic view illustrating essential parts of a photo-mask formed with a multi half tone part according to the above-mentioned manufacturing process.

[117]

[118] As illustrated in FIG.10, a half tone mask according to the present invention is implemented by forming a light transmissive part (W) on a transparent substrate (110) where the transparent substrate is exposed, and forming a structure having 3 or more parts each having a different controllable transmittance where a slit type half tone part (Z) formed only with a slit type light blocking walls, a single half tone part (Y) formed with a half tone material film (143) and a multi half tone part (X) formed with the slit type light blocking wall and a half permeation material are formed.

[119]

[120] That is, as shown in FIG.10, if the light transmissive part (W) has a 100% transmittance, the slit type half tone part (Z), the single half tone part (Y) and the multi half tone part (X) respectively have mutually different transmittances, and the irradiated light may have different wavebands according to exposure. Although there is no limit, the irradiated light generally has a waveband in the range of 300nm ~ 440nm.

[121]

[122] Any half permeation part may be employed as long as part of irradiated light is transmissive therethrough, and although there is no limit in the amount of light transmission, preferably, it should be that 10% ~99 % of irradiated light be controllably transmissive.

[123]

[124] It should be apparent that the abovementioned variously structured half tone parts may include at least one or more multi half tone parts, and may be changed to various numbers and structural designs.

[125]

[126] The structure of photo-mask according to the present exemplary embodiment may employ the light blocking layer (120) capable of completely blocking the light by itself, and according to the manufacturing process according to the present exemplary embodiment, the light blocking layer (120) may be implemented with a half permeation material layer (144) thereon. Furthermore, the slit type light blocking wall (121) may be also implemented with a half permeation material layer (142) thereon. This is because a stacking process is included for filling the half permeation material layers in the discrete spaces of the slit type light blocking walls according to the present exemplary embodiment.

[127]

[128] Particularly, the multi half tone part (X) is formed by a structure in which a slit type light blocking walls are inserted into a single half tone part to form complex half permeation parts each having a different transmittance, whereby a region capable of adjusting the transmittance can be increased in addition to the single half tone part and the slit type half tone part, whereby degrees of design freedom and degrees of correction freedom in transmittance with regard to defects can be greatly enhanced, contributing to an improved process yield, a shortened process period and an enhanced product quality after exposure.

[129]

Industrial Applicability

[130] The present invention is industrially applicable in that a pattern density of a fine pattern can be adjusted to enhance the efficiency of adjusting the transmittance in a half tone mask formed with a slit type half permeation part, a stacked type half permeation part or a combination thereof.

[131]

[132] There is another industrial applicability in that the transmittance of the half permeation region can be accurately controlled through adjustment of the pattern density without recourse to a separate manufacturing process.

[133]

[134] There is still another industrial applicability in that a multi half tone mask filled with a half permeation material in a discrete space of a slit type half permeation part to create a structure capable of controlling 3 or more mutually different transmittances.

[135]

[136] There is still further industrial applicability in that a high quality multi half tone mask can be provided by transmittance controlled through diffraction phenomenon in slit and through a half permeation material layer to greatly enhance degrees of design freedom and degrees of correction freedom in transmittance with regard to defects, contributing to an improved process yield, a shortened process period and an enhanced product quality after exposure.

Claims

[Claim 1] A half tone mask, characterized in that the half tone mask having at least one or more half permeation parts is capable of adjusting a transmittance by adjusting pattern density of a fine pattern forming the half permeation part.

[Claim 2] The half tone mask of claim 1, characterized in that the half permeation part in the half tone mask has a structure forming a fine pattern on a half permeation film, a structure forming a fine pattern on a light blocking layer and formed with a half permeation film thereon, or a combined structure thereof.

[Claim 3] The half tone mask of claim 1, characterized in that the half permeation film employs a half permeation material having a transmittance in the range of 4 ~75%.

[Claim 4] The half tone mask of claim 1, characterized in that a line width of the fine pattern is adjusted in the range of 0.1μm ~1.3μm.

[Claim 5] The half tone mask of claim 1, characterized in that the half permeation material is a material having as a main element one of Cr, Si, Mo, Ta, Ti, Al or a combined material mixed with at least the two or more elements, or a material added with at least one of Cox, Ox, Nx to the main element material or the combined material.

[Claim 6] A manufacturing method of a half tone mask having a multi half permeation part, wherein the half tone mask includes a fine pattern adjusting an optical transmittance, and wherein a pattern density of the fine pattern is adjusted, and the optical transmittance is adjusted by adjusting a line width of the fine pattern in the range of 0.1μm ~1.3μm.

[Claim 7] A half tone mask, characterized in that the half tone mask includes a light transmissive part, a light blocking part and a half permeation part that are formed on a transparent substrate, wherein the half permeation part includes a multi half tone part filled with a half tone material in slits.

[Claim 8] The half tone mask of claim 7, characterized in that the half permeation part includes at least one or more multi half tone parts, wherein the half permeation part further includes at least one of a single half tone part formed with a half permeation material layer or a slit type half tone part formed with slits only.

[Claim 9] The half tone mask of claim 7, characterized in that the multi half tone part includes a slit type light blocking wall having a predetermined

discrete space, wherein a half permeation material layer is formed at a discrete space between the slit type light blocking wall and the light blocking part.

[Claim 10] The half tone mask of claim 7, characterized in that a half permeation material layer is formed on the slit type light blocking wall and the light blocking part.

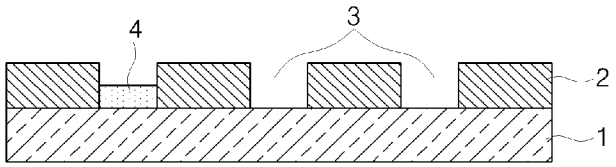
[Claim 11] The half tone mask of any one claim of claims 7,8,9 and 10, characterized in the half permeation material layer is a combined material having Mo, Si, Ta, W, Al, Cr, Hf, Zr, Me, V, Ni, Nb, Co, and Ti as main elements, and combined with the at least two or more main element materials or main elements, or a material added with at least one of Cox, Ox and Nx to the main elements or to combined material, where x is a natural number.

[Claim 12] A manufacturing method of half tone mask, characterized by: coating a photo-resist on a transparent substrate stacked with a light blocking layer (first step); patterning by exposing and developing the photo-resist (second step); forming a slit type light blocking wall and a light permeation part by etching the light blocking layer (third step); and forming a multi half tone part by stacking a half permeation material layer in the slit type light blocking wall (fourth step).

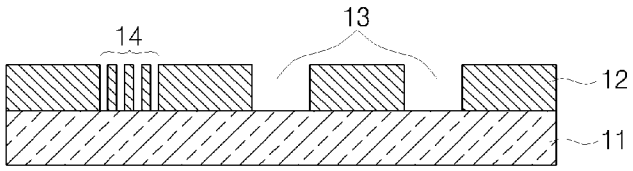
[Claim 13] The manufacturing method of claim 12, characterized in that the fourth step includes stacking a half permeation material layer on an upper surface of the light blocking layer (a 1), patterning by coating the photo-resist on the half permeation material layer (a 2), and selectively removing the half permeation material layer filled in a light transmissive part or the slit type light blocking wall through the patterned portion (a 3).

[Claim 14] The manufacturing method of claim 12 or 13, characterized in that a step of removing the photo-resist following the etching of the light blocking layer or the half permeation material layer is further included, subsequent to the third step and the fourth step.

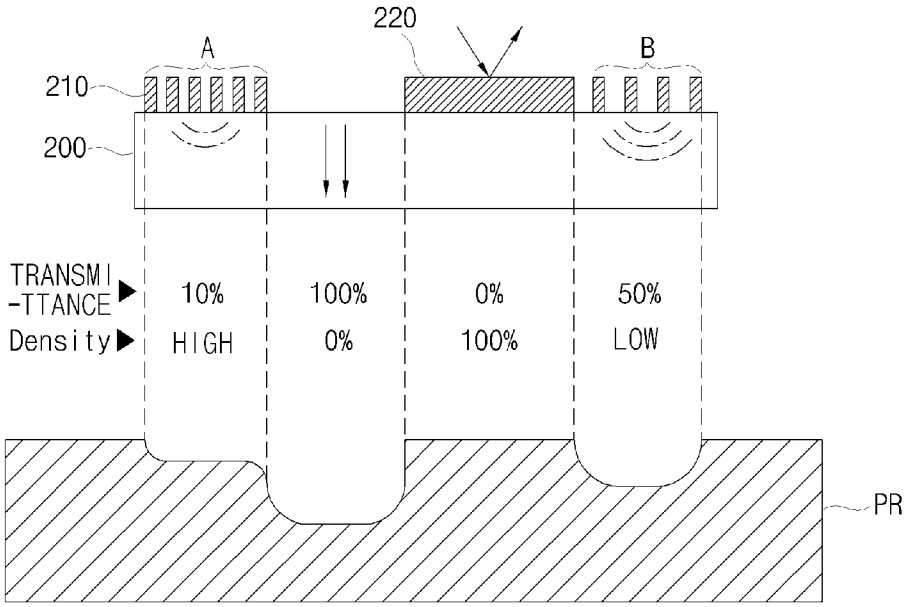
[Fig. 1]



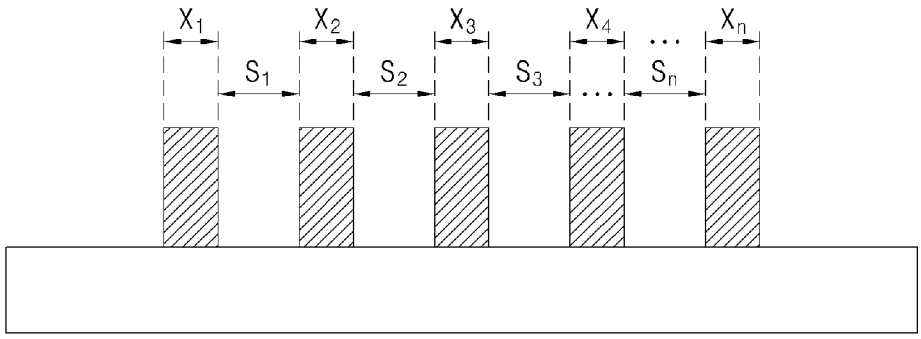
[Fig. 2]



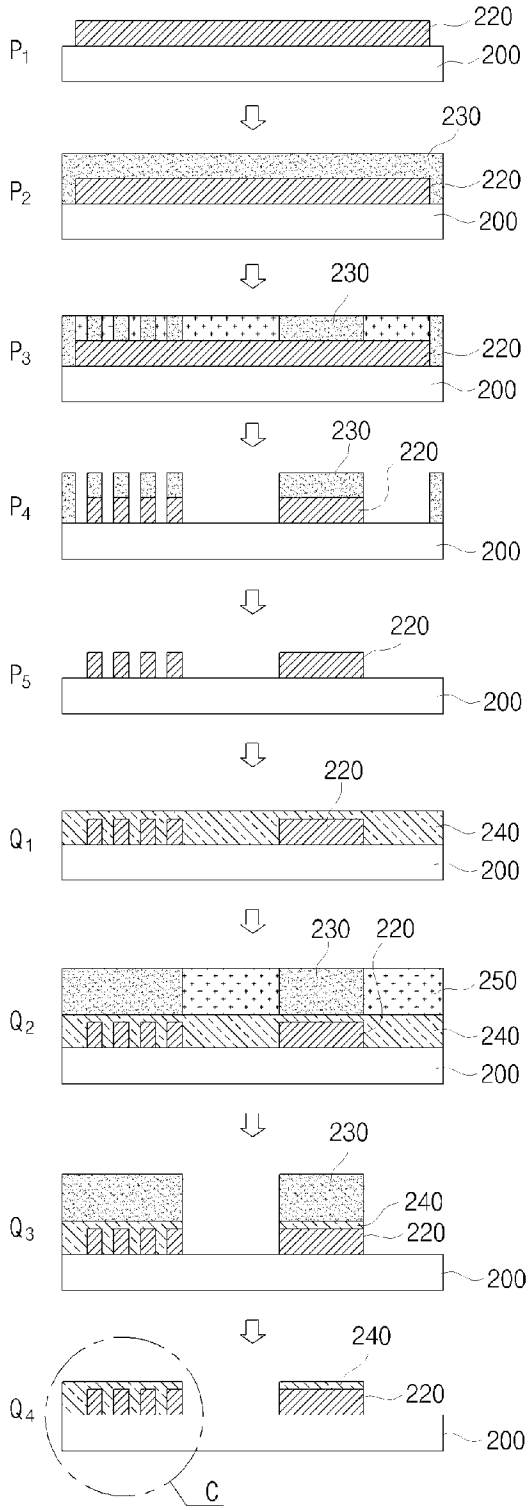
[Fig. 3]



[Fig. 4]



[Fig. 5]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Q4
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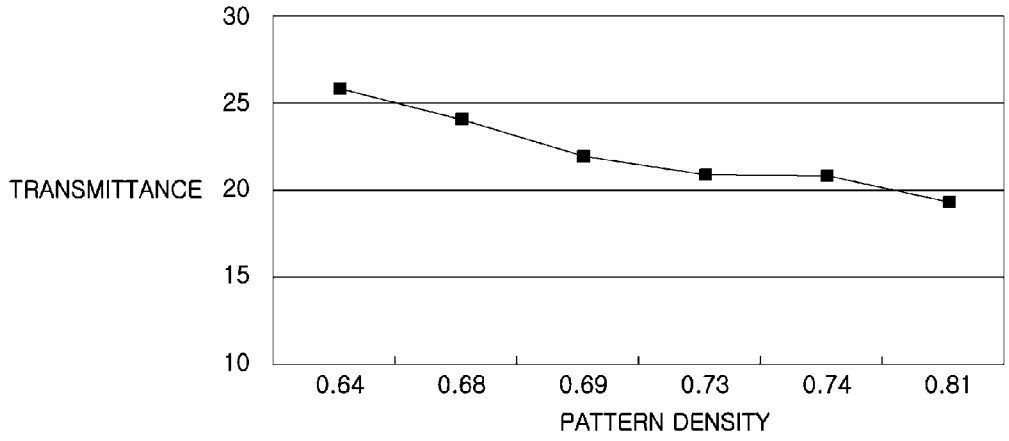
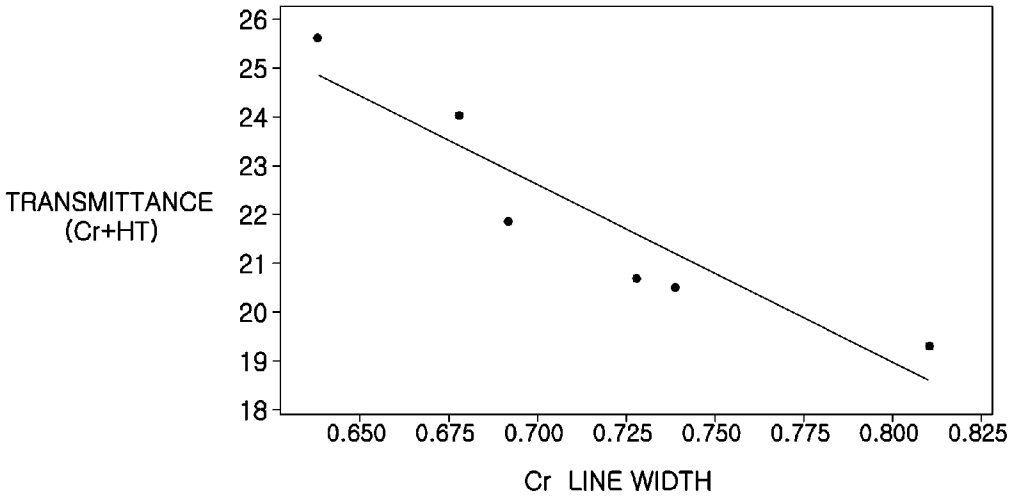
220
200
C

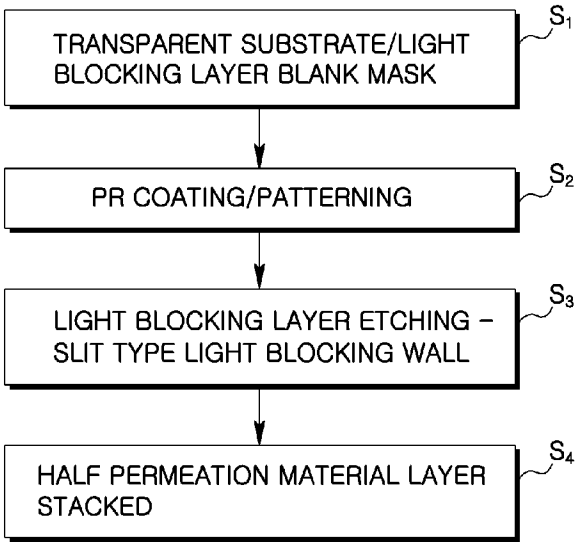
[Fig. 6]



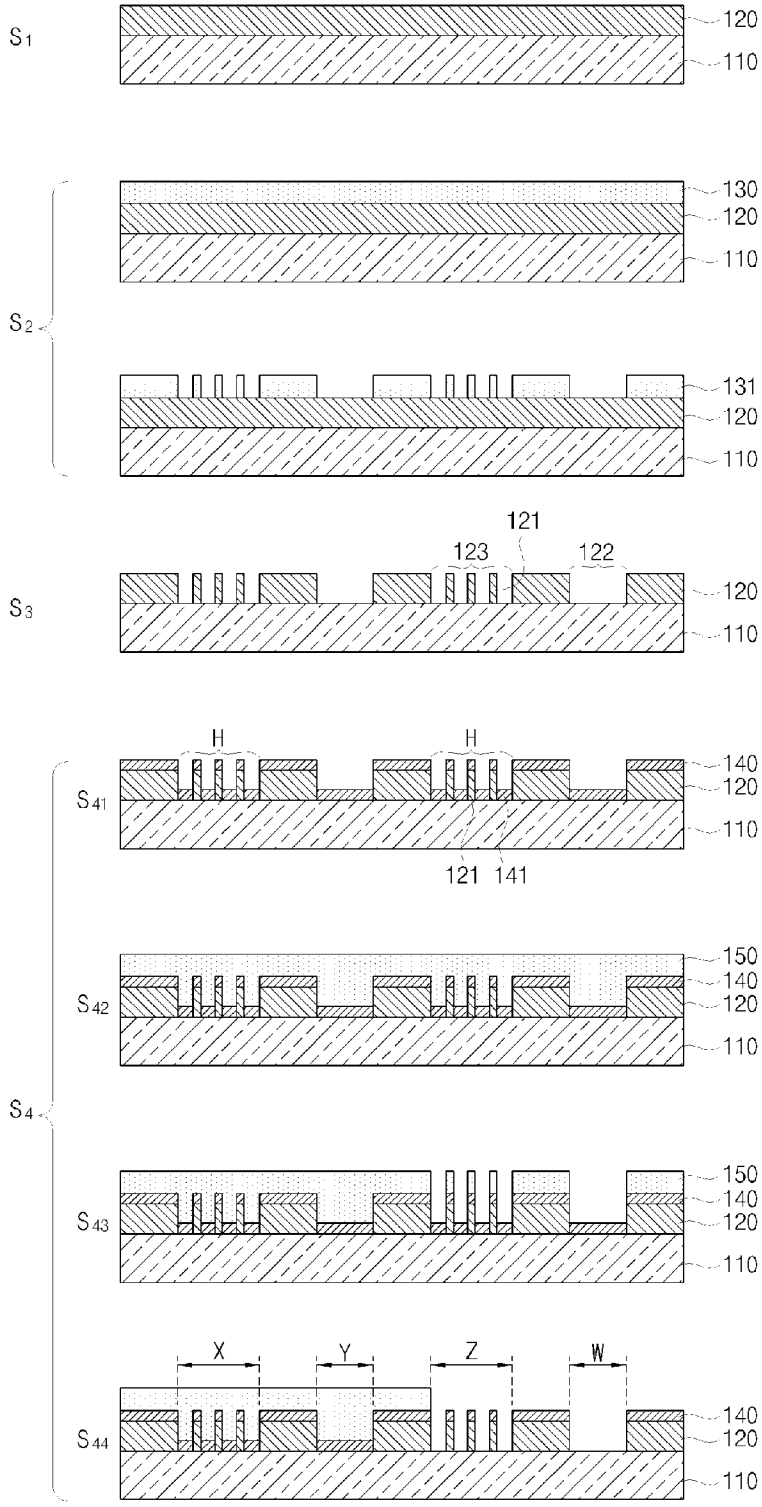
[Fig. 7]



[Fig. 8]



[Fig. 9]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S43
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S44
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Y
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110

[Fig. 10]