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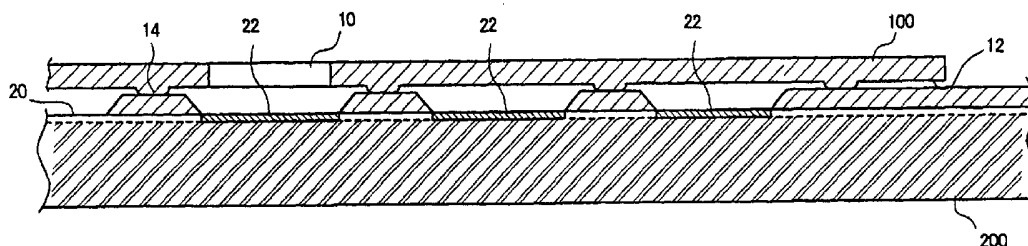
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(54) Title: MASK FOR VAPOR DEPOSITION



(57) Abstract: A thin plate-like mask for vapor deposition, formed with openings corresponding to a pattern for vapor deposition to a workpiece to be vapor-deposited on, is disclosed, wherein projections are formed on opposite faces opposite to vapor deposition target faces of the workpiece to be vapor-deposited on.

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MASK FOR VAPOR DEPOSITION

FIELD OF THE INVENTION

The present invention relates to a mask for vapor deposition on a workpiece.

BACKGROUND OF THE INVENTION

In manufacturing devices that do not need extremely fine structures such as semiconductor devices, esp., an organic light-emitting diode (organic LED), masks for vapor deposition are used for vapor depositing of metal wiring, metal electrodes, organic light-emitting materials, etc. The mask for vapor deposition is a very thin flat metal plate, etc., provided with openings corresponding to wiring patterns, etc. The mask is placed in alignment with and in the proximity of the device pattern, etc., formed on the surface of a workpiece (e.g., a glass substrate or a semiconductor substrate) to be vapor-deposited on, and the vapor-deposition material is deposited through the openings (see, e.g., Japanese Patent Application Laid-Open Publication Nos. 2002-371349 and 2002-220656). When vapor deposition is carried out, the mask for vapor deposition and the workpiece to be vapor-deposited on are placed in the proximity of each other and are aligned with each other. At this time, a problem arises in that the workpiece to be vapor-deposited on suffers damage such as scratches being made on the surface of the workpiece to be vapor-deposited or that ultra-fine particles fall off the workpiece to be vapor-deposited on as a result of contact of a portion of the mask for vapor deposition with a portion of the workpiece to be vapor-deposited on. Similarly, when the alignment has finished, damage may occur in the mask for vapor deposition and the surface of the workpiece to be vapor-deposited on due to contact between the mask for vapor deposition and the surface of the workpiece to be vapor-deposited on arising from relative positional offset therebetween. For example, when organic LEDs are formed, the fallen-off

ultra-fine particles may adhere to the light emitting areas, bringing about pixel faults, etc.

Especially, when the edge of an opening of the mask for vapor deposition comes into contact with the surface of the workpiece to be vapor-deposited on, a portion of the surface of the workpiece to be vapor-deposited on is scraped off, with the result that the fallen-off ultra-fine particles cause device defects to occur.

SUMMARY OF THE INVENTION

In view of the above problems of the prior art, the object of the present invention is to provide a mask for vapor deposition that can suppress damage occurring in a workpiece to be vapor-deposited on by reducing the surface pressure at portions that are in contact.

In order to achieve the above object, according to the main aspect of the present invention there is provided a thin plate-like mask for vapor deposition, formed with openings corresponding to a pattern for vapor deposition to a workpiece to be vapor-deposited on, wherein projections are formed on opposite faces opposite to vapor deposition target faces of the workpiece to be vapor-deposited on.

The projections are preferably formed at positions corresponding to positions outside effective areas of devices formed on the surface of the workpiece to be vapor-deposited on when the mask for vapor deposition is aligned with the workpiece to be vapor-deposited on. This prevents the projections themselves from coming into direct contact with the device effective regions (e.g., the light-emitting regions of organic LEDs), thus resulting in fewer occurrences of damage to the effective areas of the devices.

In this case, the projections are preferably shaped (as, e.g., a circle, a rectangle, an ellipse or a frame-like form) with a planar portion along the opposite face. Since the projections have the planar portion in this manner,

the edge of the openings of the mask for vapor deposition and the workpiece to be vapor-deposited on can be prevented from coming into contact with each other due to flexure etc., of the mask for vapor deposition, and also damage to the workpiece to be vapor-deposited on can be prevented by reducing the
5 surface pressure at the portions that are in contact.

Furthermore, the projections preferably have the height of 1 μm or larger and 10 μm or smaller. For example, for a device pattern of LEDs having spacing of the adjacent effective areas of approximately 20 μm to 200 μm , the minimal value of the height is preferably 5 μm or larger and 50 μm or
10 smaller.

According to the present invention, occurrences of damage which may be caused by the contact of the mask for vapor deposition with the workpiece to be vapor-deposited on can be reduced.

BRIEF DESCRIPTION OF THE DRAWINGS

15 The above and other objects, aspects, features and advantages of the present invention will become more apparent from the following detailed description when taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a plan view of a mask for vapor deposition
20 according to an embodiment of the present invention;

FIG. 2 is a cross-sectional view of the mask for vapor deposition according to the embodiment of the present invention;

FIG. 3 illustrates a form during the use of the mask for vapor deposition according to the embodiment of the present invention;

25 FIG. 4 is a plan view showing the arrangement of color LEDs;

FIG. 5 is a plan view of a modification of the mask for vapor deposition according to the embodiment of the present invention;

FIG. 6 is a plan view of another modification of the mask for

vapor deposition according to the embodiment of the present invention; and

FIG. 7 is a plan view of a further modification of the mask for vapor deposition according to the embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

5 FIG. 1 is a plan view of a mask 100 for vapor deposition in accordance with an embodiment of the present invention. FIG. 2 is a cross-sectional view of the mask 100 for vapor deposition taken along the line A-A in FIG. 1.

 The mask 100 for vapor deposition employs a metal planar
10 plate, as a substrate of the mask 100, having the thickness of approximately 10 μm to 100 μm . As the metal planar plate, for example, an alloy material such as Ni-Co can be used. The mask 100 for vapor deposition is formed with openings 10. The openings 10 are provided such that the openings 10 form a pattern for vapor deposition corresponding to the device pattern formed on a
15 workpiece to be vapor-deposited on.

 When vapor deposition is carried out, as shown in FIG. 3, the mask 100 for vapor deposition is arranged such that the mask 100 for vapor deposition covers a face 20 (hereinafter, referred to as vapor deposition target face 20) that is the targeted area for the vapor deposition of a workpiece 200 to
20 be vapor-deposited on, with a device pattern formed on the vapor deposition target face 20 of the workpiece 200 to be vapor-deposited on being in alignment with the pattern of the openings of the mask 100 for vapor deposition. Then, the mask 100 for vapor deposition and the workpiece 200 to be vapor-deposited on are introduced into a vacuum chamber while
25 maintaining their alignment to effect vapor deposition on the vapor deposition target face 20 with the vapor deposition pattern corresponding to the pattern of openings.

 For example, when the workpiece 200 to be vapor-deposited

on is a light-emitting unit of a color organic LED shown in FIG. 4, the pattern of openings of the mask 100 for vapor deposition shown in FIG. 1, the mask 100 is for carrying out vapor deposition only on light-emitting areas 22R (areas indicated by hatching) for the color R (Red) formed on the vapor deposition target face 20. When vapor deposition is carried out on light-emitting areas 22G for the color G (Green) or on light-emitting areas 22B for the color B (Blue), a mask for vapor deposition may also be prepared, on which openings 10 are disposed at positions corresponding to the light-emitting areas 22G for the color G (Green) or the light-emitting areas 22B for the color B (Blue).

10 As shown in FIGS. 1 and 3, projections 14 are provided around the openings 10 on a face 12 (hereinafter, referred to as opposite face 12) of the mask 100 for vapor deposition, that is opposite to the vapor deposition target face 20. The projections 14 can be formed at the same time by patterning when the pattern on the mask 100 for vapor deposition is formed by etching or plating.

In addition to a circular shape shown in FIG. 1, the shape of the projections 14 is preferably a rectangular or an elliptical shape, as shown in FIG. 5, a beam-like shape extending in any of the directions along the opposite faces 12, such as a frame-like shape shown in FIG. 6, or a comb-like shape as shown in FIG. 7. In this case, it is preferable for the ratio of the width of the major axis along the direction of the extension, to the width of the minor axis orthogonal to the major axis, to be 1.5 or larger. In this manner, by employing the horizontally extended beam-like shape as the shape of the projections 14, the opposite face 12 of the mask 100 for vapor deposition can be supported above the vapor deposition target face 20 of the workpiece 200 to be vapor-deposited on more securely without causing any damage to the surface of the workpiece 200 to be vapor-deposited on, and the spacing between the vapor deposition target face 20 and the opposite face 12 can be maintained at

least at the height of the projections without being affected by flexure, etc., of the mask 100 for vapor deposition. Consequently, rubbing of the opposite face 12 with the vapor deposition target face 20 and damage caused by the contact of the vapor deposition target face 20 with the edges of the openings 10
5 can be more securely prevented.

With the workpiece 200 to be vapor-deposited on aligned with and the mask 100 for vapor deposition, as shown in FIG. 3, the projections 14 are preferably formed at positions that do not overlap the effective areas 22 of the devices, such as, for example, the light-emitting areas of the color
10 organic LEDs, formed on the workpiece 200 to be vapor-deposited on. By forming the projections 14 at such positions, the projections 14 are not brought into direct contact with the effective areas 22 of the devices during the alignment or after the alignment. Thereby, fewer occurrences of damage are caused in the effective areas 22 of the devices.

15 Furthermore, as shown in FIG. 3, the projections 14 are preferably formed in the vicinity of the center between the device effective areas 22 formed on the workpiece 200 to be vapor-deposited on. In addition, the width of the projections 14 is determined by the size of the device formed on the workpiece to be vapor-deposited on or the size of the pattern of
20 openings of the mask 100 for vapor deposition. The maximum width $B_{\max}$ of the projections 14 in the direction of the minor axis is preferably sufficiently narrower than the spacing between the effective areas 22 of the device formed on the workpiece 200 to be vapor-deposited on. By employing such an arrangement and width as described above, the projections 14 can be prevented
25 from directly contacting the device effective areas in the case where the positions of the workpiece 200 to be vapor-deposited on and the mask 100 for vapor deposition relative to each other shift while the alignment is being carried out or in the case where the positions of the workpiece 200 to be

vapor-deposited on and the mask 100 for vapor deposition relative to each other are unintentionally shifted after the alignment has been carried out. Therefore, damage to the effective areas 22 of the device can be prevented from occurring.

5 Furthermore, the minimum width $B_{\min}$ of the projections 14 in the direction of the minor axis is preferably one fifth (1/5) or more of the spacing between adjacent effective areas 22. For example, for the color organic LEDs shown in FIG. 4, since the spacing between adjacent R (Red), G (Green) and B (Blue) light-emitting areas is approximately 20 μm to 200 μm ,
10 the minimum width $B_{\min}$ of the projections 14 is preferably approximately 4 μm to 40 μm . Thereby, the opposite face 12 of the mask 100 for vapor deposition can be more securely supported above the vapor deposition target face 20 of the workpiece to be vapor-deposited on, and the vapor deposition target face 20 and the opposite face 12 can be held maintaining a
15 predetermined spacing therebetween.

 Furthermore, the height H of the projections 14 is preferably 1 μm to 10 μm . When the height is smaller than 1 μm , damage to the effective areas 22 caused by the contact of the workpiece 200 to be vapor-deposited on and the mask 100 for vapor deposition can not be prevented.
20 Also, when the height H is larger than 10 μm , the spacing between the workpiece 200 to be vapor-deposited on and the mask 100 for vapor deposition becomes too wide and problems arise including the deposited pattern being deformed.

 Furthermore, as shown in FIG. 2, the end portion of the
25 projections 14 is preferably rounded with a certain curvature. In this case, the relationship between the height H and the projection width B is preferably $B/H \geq 2$ and the curvature R for this case is preferably almost the same as H. Thereby, there is less damage inflicted on the vapor deposition target face 20

when the projections 14 are brought into contact with the vapor deposition target face 20 of the workpiece 200 to be vapor-deposited on.

Still further, as shown in FIG. 3, the openings 10 of the mask 100 for vapor deposition are formed somewhat smaller than the effective areas 22 of the device that is the target of the vapor deposition, considering the spread caused by splashing of the material to be deposited during the vapor deposition. Therefore, the projections 14 are preferably provided at positions slightly away from the openings 10 so as not to block the lines joining the deposition source and the effective areas 22.

As set forth hereinabove, according to the mask for vapor deposition of the embodiment, the occurrences of damage which may be caused by the contact of the mask for vapor deposition with a workpiece to be vapor-deposited on can be reduced.

While illustrative and presently preferred embodiments of the present invention have been described in detail herein, it is to be understood that the inventive concepts may be otherwise variously embodied and employed and that the appended claims are intended to be construed to include such variations except insofar as limited by the prior art.

PARTS LIST

10	openings
14	projections
20	target face
22	effective area
22R	light-emitting areas for red
22G	light-emitting areas for green
22B	light-emitting areas for blue
100	mask
200	workpiece

CLAIMS:

1. A thin plate-like mask for vapor deposition, formed with openings corresponding to a pattern for vapor deposition to a workpiece to be vapor-deposited on, comprising:
 - 5 projections formed on opposite faces opposite to vapor deposition target faces of the workpiece to be vapor-deposited on.
2. A mask for vapor deposition according to claim 1, wherein:
 - 10 the projections are formed at positions corresponding to positions outside effective areas of devices formed on the surface of the workpiece to be vapor-deposited on when the mask for vapor deposition is aligned with the workpiece to be vapor-deposited on.
3. A mask for vapor deposition according to claim 1, wherein:
 - 15 the projections have a beam-like shape extending along the opposite faces.
4. A mask for vapor deposition according to claim 3, wherein:
 - 20 the shape of the projections is circular, elliptical or oval.
5. A mask for vapor deposition according to claim 1, wherein:
 - the projections have a height of 1 μm or larger and 10 μm or smaller.
6. A mask for vapor deposition according to claim 1, wherein:
 - 25 the projections have a minimum width that is one fifth (1/5) or larger of spacing between the adjacent effective areas.

7. A mask for vapor deposition according to claim 1,
wherein:
the projections have a minimum width of 4 μm or larger and
40 μm or smaller.

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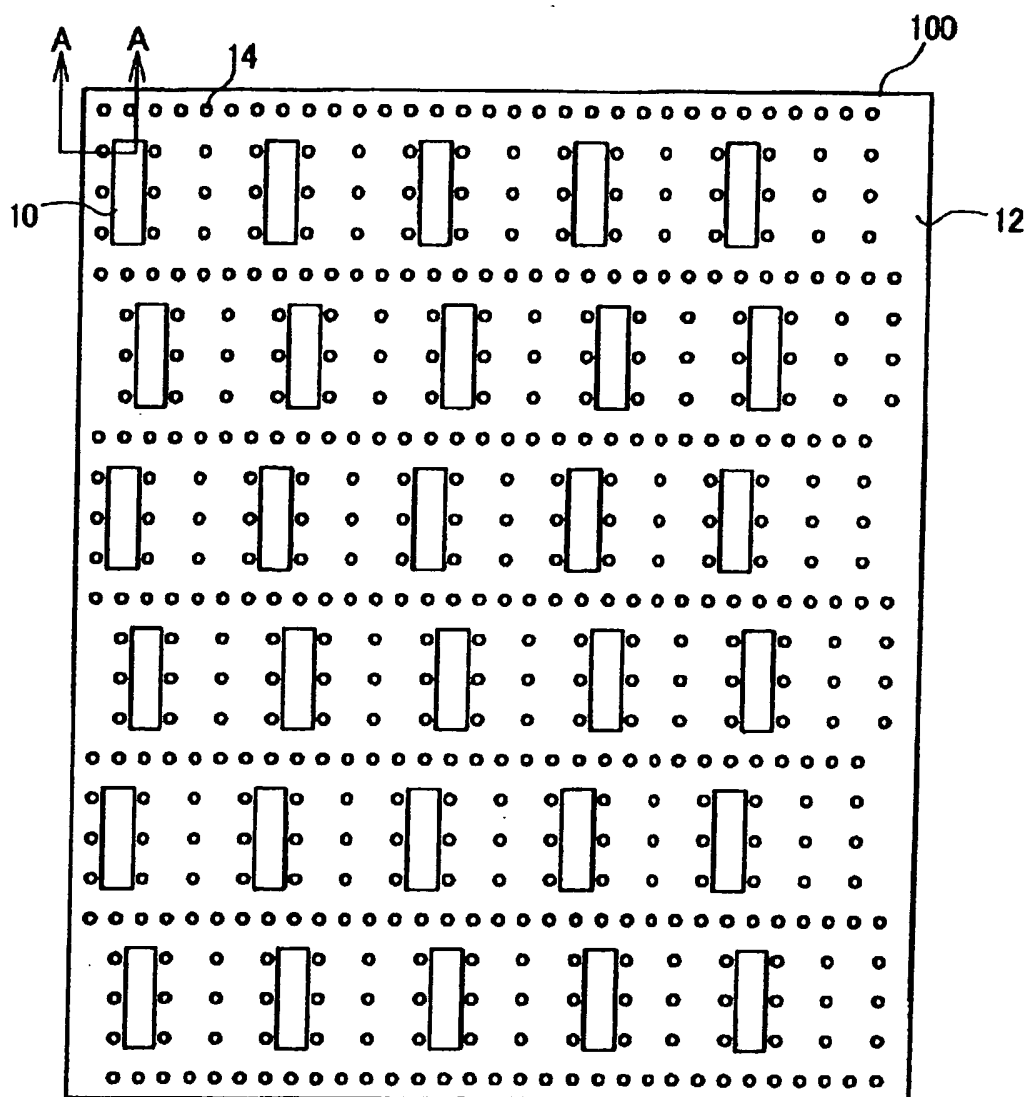


Fig. 1

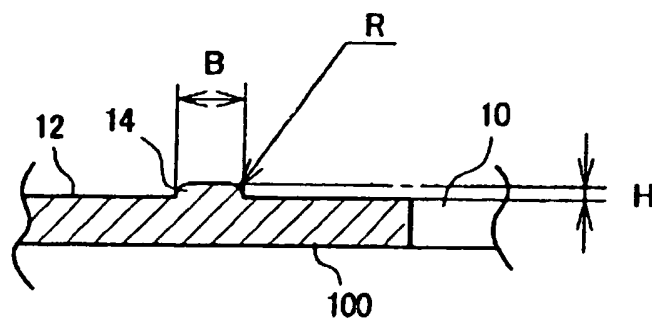


Fig. 2

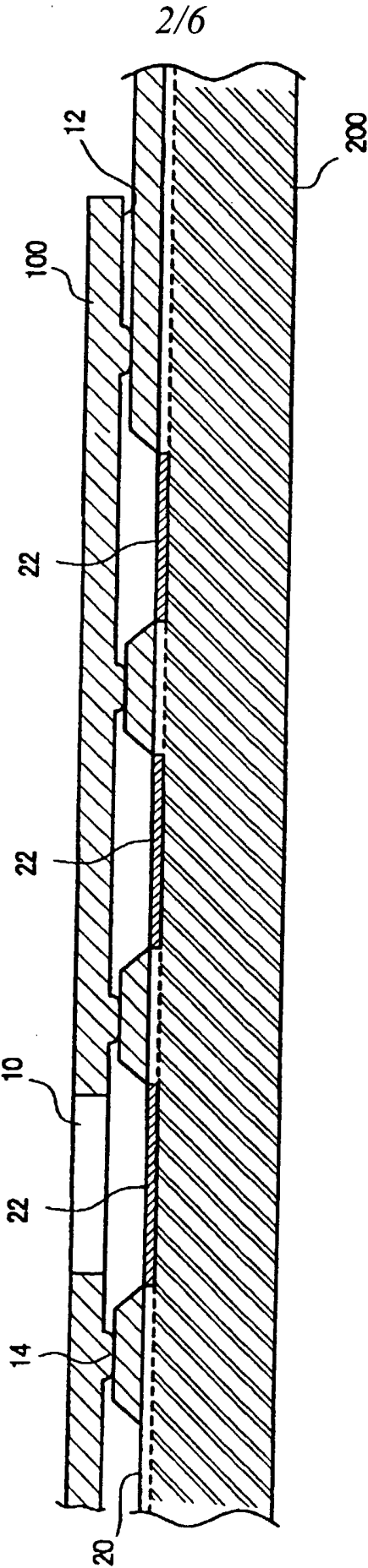


Fig. 3

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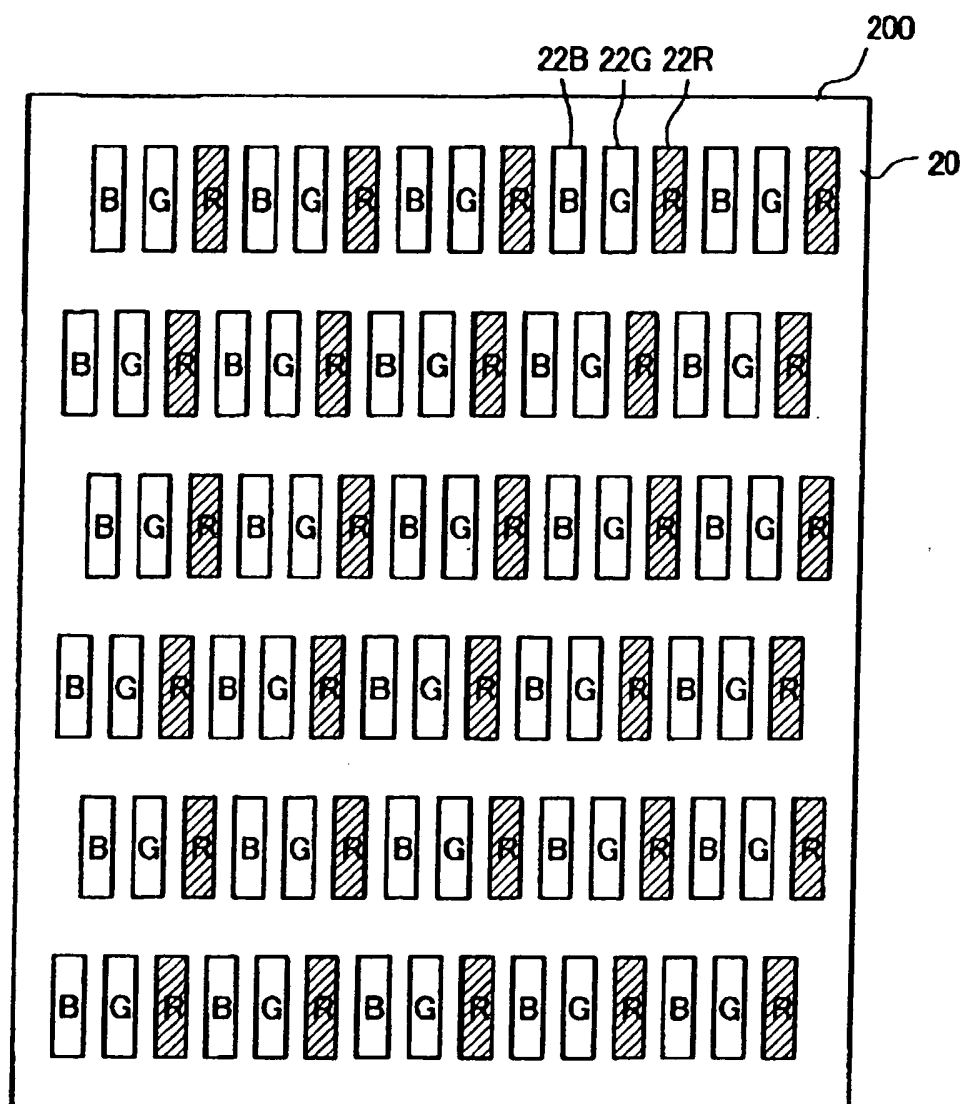


Fig. 4

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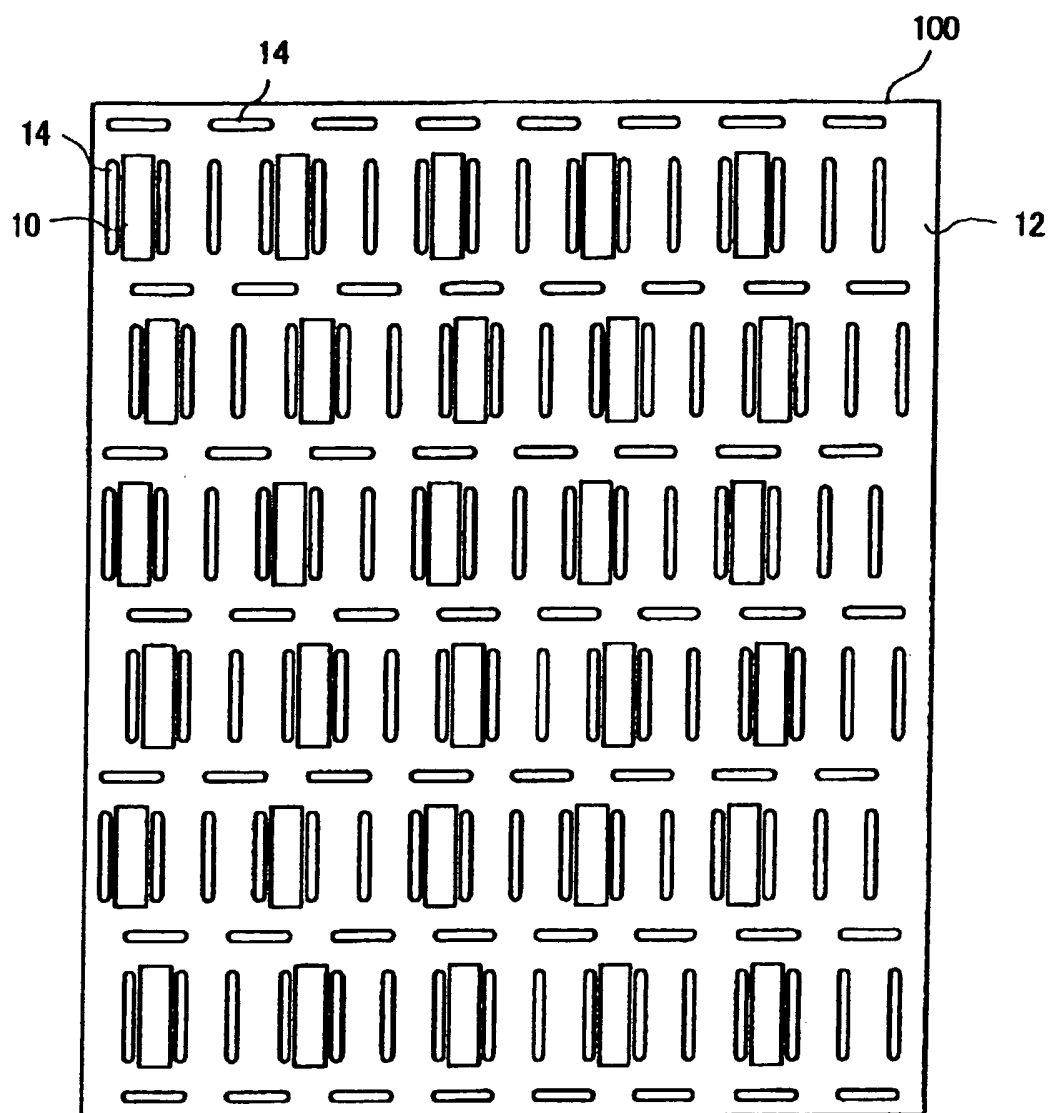


Fig. 5

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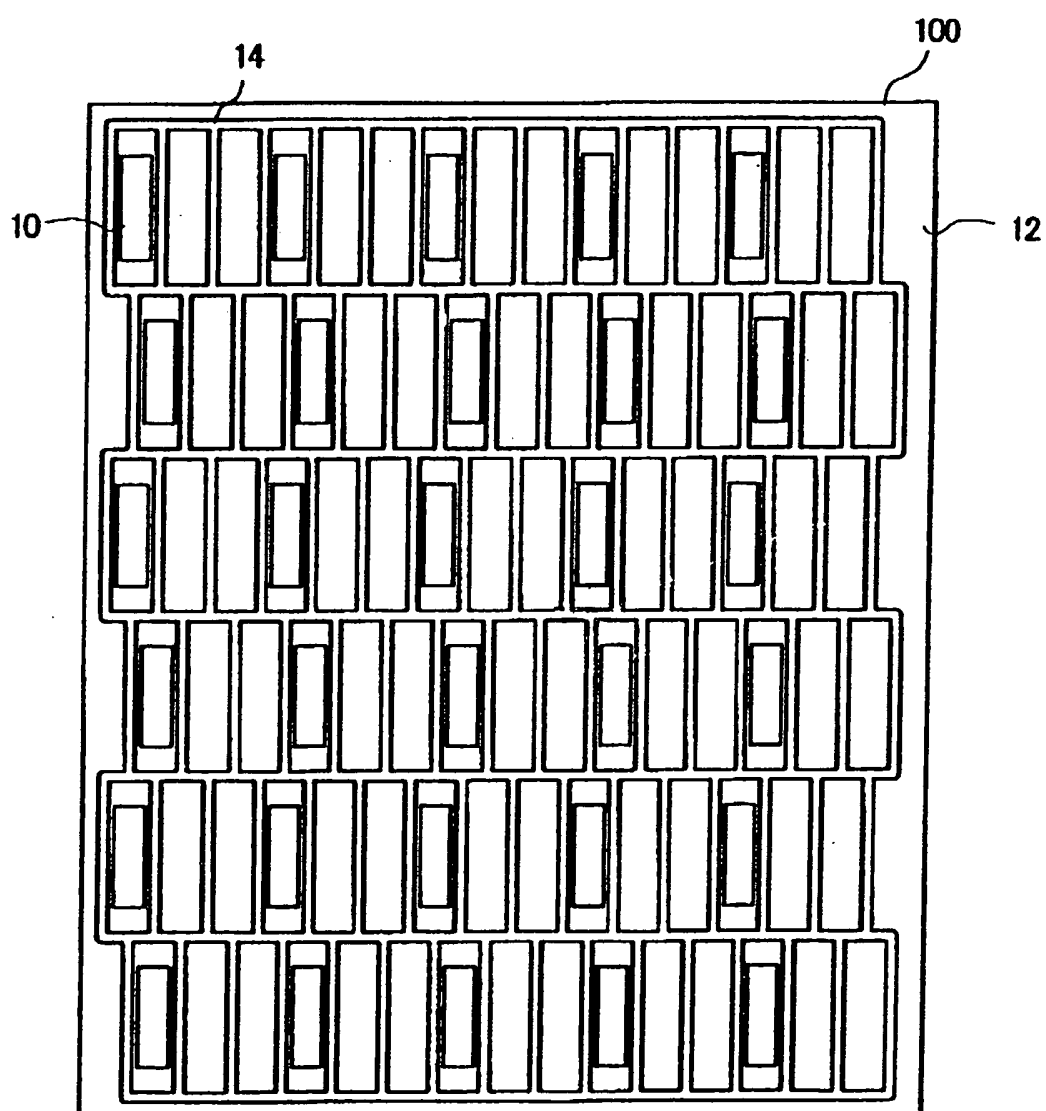


Fig. 6

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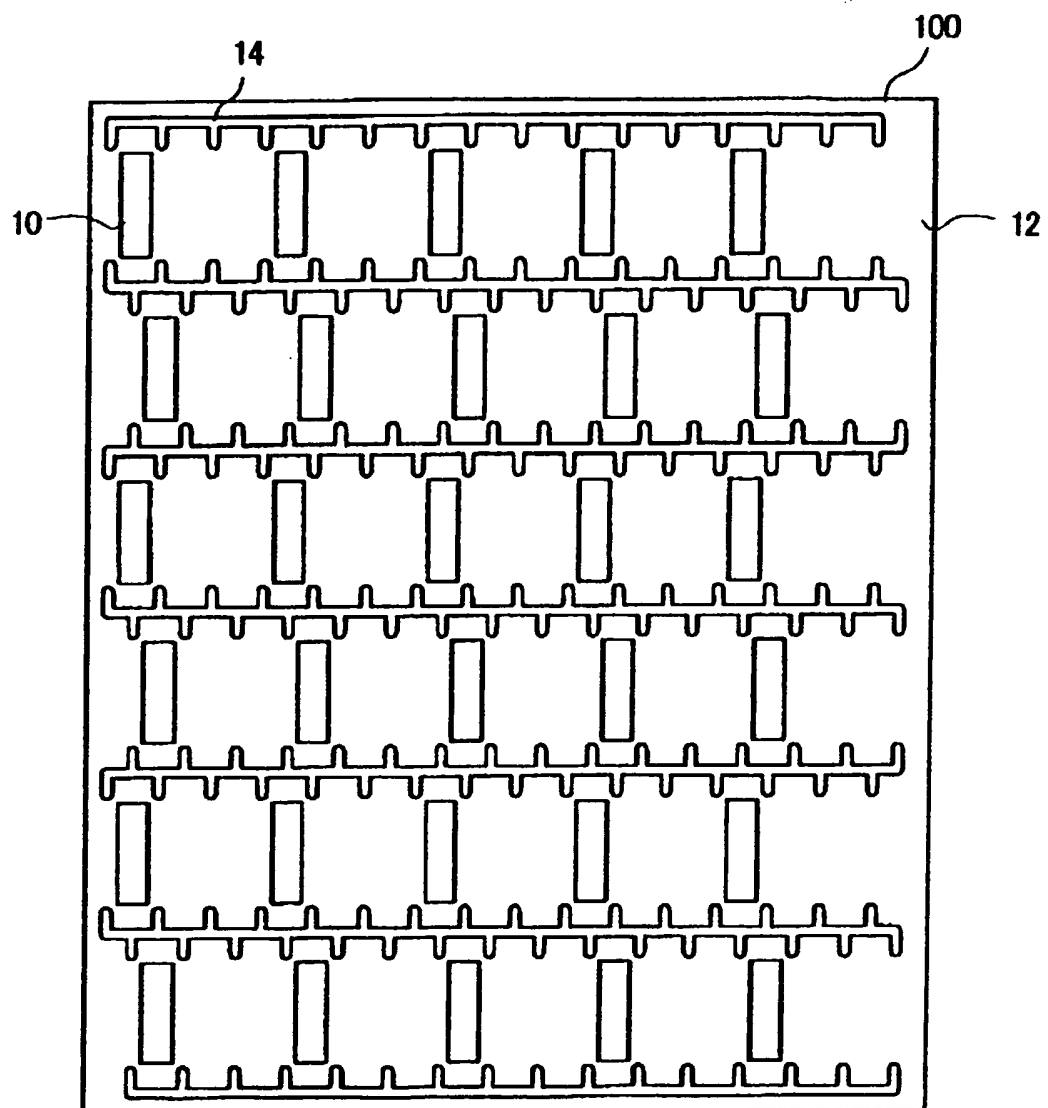


Fig. 7