

An Integrated Shadow Mask and Method of Fabrication Thereof

5 FIELD OF INVENTION

The present invention relates broadly to an integrated shadow mask and a method of fabrication thereof, and to a method of fabricating an organic light emitting device.

10 BACKGROUND

OLEDs are electroluminescent (EL) devices that emit light generated by radiative recombination of injected electrons and holes within one or more organic EL layers of the OLEDs. As the leading next-generation flat panel display technology, OLED offers some unique display solutions, such as low-power consumption, wide viewing angle,
15 good contrast, video rate operation, low-voltage operation, and lightweight. OLED display devices are also thermally stable with adequate operating lifetime for certain applications.

A typical OLED configuration consists of organic functional layers (inclusive of at least a light-emitting organic layer) sandwiched between two electrodes. One of the
20 electrodes (anode) injects positive charge carriers, and the other electrode (cathode) injects negative charge carriers. In a typical OLED device, the light emitting materials can be either polymer or small molecules. The anode layer is usually made of a transparent conducting material, such as indium tin oxide (ITO); while the cathode layer a conducting metal with a low work function, such as Ca or Mg.

25 Flat panel displays typically include an array of picture elements, or pixels, deposited and patterned on a substrate. Such a pixel array is typically a matrix of rows and columns. In passive-matrix OLED displays, the individual pixels are defined by the overlap of ITO columns (anodes) and metal rows (cathodes). To cause a particular pixel to illuminate, a sufficient voltage is applied between the column (positively polarized)
30 and the row (negatively polarized) lines crossing at that particular pixel. The anode strips can easily be formed by using conventional photolithography and wet etching processes before the organic layers are deposited. However, the cathode cannot be patterned in the same way because the developer and the etching solution would

cause damage to the underlying organic compounds. The simplest approach to form cathode patterns is vacuum evaporation of the cathode metal through a separate shadow mask. With such an approach it is, however, difficult to achieve fine-definition patterns, say patterns with line spacing of 100 μm or less, because of the limitations in manufacturing precision and the strength of the mask materials. In the fabrication using such a shadow mask, alignment in a vacuum system is also difficult, and the distance between the mask and the substrate would result in blurred edges.

One technique that may be used to protect the delicate organic layers of an OLED is an integrated mask through which organic and electrode layers can be automatically patterned. U. S. Pat. No. 5,294,870 (published 4 January 1994) to Tang (Organic electroluminescent multicolor image display device) discloses the use of a series of parallel walls formed by photolithography prior to deposition of an organic EL layer such that photolithographic patterning steps or wet chemistry are not required after the organic EL medium is deposited. To achieve a deposition pattern of the cathode in laterally spaced columns the deposition surface is positioned in relation to the source of metal to be deposited such that each wall is interposed between the source and an adjacent portion of the surface of the organic EL medium. When deposition is undertaken in such an orientation the interposed portions of the walls intercept metal atoms travelling from the source, thereby preventing metal deposition on the organic EL medium on one side of each wall. This provides the spacing between adjacent rows of cathode. However, this integrated mask requires a fixed extreme off-axis or large angular deposition, which is not viable for mass production where moving conveyor belt or rotator is needed.

To solve this problem, the parallel walls in the integrated mask may be a series of pillars with retrograde profile (trapezoidal shape in cross-section), using a multi-layer photoresist system to form resist-pillars with sloped edges. The retrograde angle of the pillar must be sufficient to ensure that the cathode metal does not coat the sidewalls and electrically short adjacent rows. The required pillar profile is primarily dependent on the relative orientation of the cathode source to the substrate. Therefore, the retrograde pillar profile still maintains limitations to the deposition angle.

U. S. Pat No. 6,407,408 (published 18 June 2002) and 6,596,443 (published 22 July 2003) to Weaver et al disclose single layer integrated masks with clear features of curved profiles of sidewalls and an overhang by using a different photoresist system

(such as NR7-6000-PY). The mask has a large aspect ratio of at least 1.5, defined as the ratio of depth to height of the undercut. However, the large aspect ratio makes the pillars very fragile if a fine-definition mask is required. Furthermore, the limitation to deposition angle still exists in this integrated mask although the available deposition angle has been enlarged.

Although the base-undercut-overhang structure in the integrated masks is widely used to mitigate shorting across the mask, the process used to deposit the electrode must meet certain criteria to avoid shorting problems. The shorting between the parallel electrode strips is caused by the undesirable covering of conductive material over the pillar walls.

10 The first source of the undesirable coverage is scattering of metallic atoms during evaporation, while the scattering, to large extent, depends on deposition processes and material to be deposited. For example, chemical vapor deposition process exhibits more scattering than physical deposition process. The second contribution to the undesirable coverage is from off-axis or angular deposition. Off-axis deposition is deposition from an

15 angle not perpendicular to the substrate, which may result in the recessed surfaces under overhang losing protection from a direct line of sight to the source of material being deposited. Therefore, in order to avoid shorting problem with the conventional integrated mask, materials and deposition processes typically are limited to those producing small scattering. For example, ITO patterning in top-emitting OLEDs is not typically performed

20 with such masks as the relevant CVD or sputtering typically required involves large scattering.

To mitigate the problem of limitation to deposition angle, U. S. Pat. No. 5,701,055 (published 23 December 1997) to Nagayama et al discloses a two layer patterning system with a SiO₂ overhang and a polyimide undercut. The oxide overhang is

25 produced by photolithography and reactive-ion etching processes, and the polyimide undercut is formed by wet-etching in an alkali solution or the combination of reactive-ion etching and the wet-etching. However, the overhang is quite fragile because of the weak adhesion between the thick SiO₂ and the polyimide, which may result in peeling off of the overhang from the base during the subsequent wet-etching and

30 drying processes. Furthermore, the dimension of the polyimide is largely dependent on wet-etching parameters, which may result in an undesirable shape and a problem in uniformity.

- Similarly, U. S. Pat. No. 6,013,538 (published 11 January 2000) to Burrows et al discloses a multilayer patterning system with an overhang and an undercut for deposition of organic, cathode and protective layers. A ~200nm thick insulating layer (SiO_x , TiO_2 , SiN_x or polyimide) is deposited on the substrate with anode strips. The
- 5 insulating layer is then patterned into strips using an appropriate method to expose the anode area for light emission. Based on the insulating strips, another insulating layer and a photoresist layer are formed in sequence. The overhang of the photoresist and the undercut of the insulating layer are then formed by developing and chemical etching processes accordingly.
- 10 Another multilayer integrated mask was disclosed in *Christophe Py, Dan Roth, Isabelle Lévesque, John Stapledon, Anne Donat-bouillud, Synthetic Metals 422 (2001) 225-227* (published 1 May 2001), using dense SiO_2 layer, followed by a porous SiO_2 layer, and capped by Si_3N_4 deposited by PECVD and patterned by traditional photolithography process.
- 15 The pattern is transferred by etching the stack of insulators in a buffered hydrofluoric acid solution. A structure containing a base layer of dense SiO_2 , an undercut layer of porous SiO_2 , and an overhang layer were produced by using the different etching rates of the dense SiO_2 (100nm/min), porous SiO_2 (250nm/min), and Si_3N_4 (40nm/min). It is clear that physical or chemical vapor deposition processes are required for fabrication of
- 20 these T shaped integrated masks, resulting in higher fabrication cost. In addition, the acidic solution in chemical etching process used for the undercut formation also attacks the transparent anode layer, which is normally indium tin oxide (ITO).

- A need therefore exists to provide an alternative integrated shadow mask design and fabrication method that seeks to address at least one of the above-mentioned
- 25 disadvantages.

SUMMARY

- 30 In accordance with a first aspect of the present invention there is provided an integrated shadow mask comprising a substrate; at least one pillar structure having a base portion and an overhang portion supported by the base portion; wherein the base portion and the overhang portion are formed integrally and the overhang

portion includes an undercut surface portion extending from an edge of the overhang portion towards the base portion substantially parallel to or diverging away from a surface of the substrate.

The undercut surface portion may comprise a groove.

5 The base portion may be formed on a base layer formed on the substrate.

The base layer may extend from the base portion to at least a point on the surface of the substrate where a surface normal from the surface is aligned with the edge of the overhang portion.

10 Each pillar structure may be formed as a strip extending on the surface of the substrate.

The mask may further comprise a first electrode layer formed between the surface of the substrate and the base portion of the pillar.

The substrate may comprise a flexible substrate.

15 In accordance with a second aspect of the present invention there is provided a method of fabricating an integrated shadow mask, the method comprising providing a substrate; forming at least one pillar structure on the substrate, the pillar structure having a base portion and an overhang portion supported by the base portion; wherein the base portion and the overhang portion are formed integrally and the overhang portion includes an undercut surface portion extending from an edge of the overhang portion towards the base portion substantially parallel to or diverging away from a surface of the substrate.

20 The method may further comprise forming a groove in the undercut surface portion.

The method may further comprise forming a base layer on the substrate, and forming the base portion on the base layer.

25 The base layer may extend from the base portion to at least a point on the surface of the substrate where a surface normal from the surface is aligned with the edge of the overhang portion.

Each pillar structure may be formed as a strip extending on the surface of the substrate.

30 The method may further comprise forming a first electrode layer between the surface of the substrate and the base portion of the pillar.

Forming the pillar structure may comprise forming an undercut regulator on the substrate; depositing a pillar material over the undercut regulator; and removing the undercut regulator to release the overhang portion of the pillar structure from

35 the substrate.

The substrate may comprise a flexible substrate.

In accordance with a third aspect of the present invention there is provided a method of fabricating an organic light emitting device utilising the mask as defined in the first aspect.

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BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1a and b show schematic cross sectional views of the "Γ" shaped integrated shadow masks.

10 FIG. 2a and b show respective series of schematic cross sectional views illustrating the fabrication of the "Γ" shaped masks of Fig. 1a and b respectively.

FIG. 3a and b show a schematic perspective view and a schematic cross-sectional view respectively of an OLED display device with passive-matrix, which is fabricated by using the "Γ" shaped mask of Fig. 1b.

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DETAILED DESCRIPTION

An integrated mask having a pillar profile of a "Γ" shape is described. The mask structure has practically no limitation to deposition angle, materials to be deposited, and vapor deposition process, and thus enables the use of processes that were not previously applicable for top electrode deposition, such as CVD, PVD sputtering with highly off-axis deposition.

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A method for fabrication of an integrated mask is also described, which is specifically suitable for high yield mass production of high resolution OLED devices, which is difficult to be realized with previous masks.

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A method of using the integrated mask to fabricate a passive matrix OLED device is also described.

FIG. 1a and 1b schematically show the cross sectional views of "Γ" shaped masks 100, 150 respectively. The only difference between design 100 and design 150 is that the overhang in design 150 has an additional groove 152 on its bottom surface 154.

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The groove 152 can be in any available geometric shape, such as square, rectangle, triangle, curve, etc. Depending on the mask design, the height of the undercut 102 can be in the range of about 2 to about 20 μm , preferably about 2 to about 4 μm for high resolution. The aspect ratio (defined as the depth to the height of the undercut 102) can be from about 0.5 to about 3.0, preferably, about 1.0 to about 2.0. The overhang 104 thickness can be from about 2 to about 10 μm , preferably from about 3 to about 6 μm . The pillar base 106 and the overhang 104 are formed integrally and the overhang 104 includes an undercut surface portion 107 extending from an edge 109 of the overhang 104 towards the pillar base 106 substantially parallel to the surface 110 of the substrate 112. The undercut surface portion 107 may extend from the edge 109 of the overhang 104 towards the pillar base 106 substantially diverging away from to the surface 110 of the substrate 112 in other mask designs.

The dimension of the pillar base 106 is dependent of the desired device resolution. The higher the requested resolution, the smaller the pillar base 106. However, the pillar base 106 is preferably wide enough for desired pillar strength. Advantageously, the width of the pillar base 106 is at least the same as the total height of the pillar 108. Base layers 114 extend from the pillar base 106 to at least a point on the surface 110 of the substrate 112 where a surface normal (not shown) from the surface 110 is aligned with the edge 109 of the overhang 104.

Also shown in FIG. 1a and b is a metallic layer 116 deposited over the masks 100 and 150, illustrating the discontinuity in the metallic layer 116 caused by the undercut 102, thus avoiding electrically shortening between adjacent strips of top electrodes 118 of the metallic layer 116.

FIG. 2a shows a typical fabrication process for the "I" shaped mask 100. Starting with a patterned bottom electrode (or anode) 200 formed on a substrate 201, a base layer 202 with pixel windows 204 is formed. The materials of the base layer 202 may be UV curable polymers, such as benzocyclobutene (BCB) and polyimide, and patterned by standard photolithography. Alternatively, the base layer 202 can be made of oxides, such as SiO_2 , Al_2O_3 and TiO_2 , by sol-gel or vapor deposition and patterned by photolithography and/or chemical etching. Undercut regulators 206 are then formed on to the base layer 202. The regulators 206 are adjustable in thickness by selecting different photoresists and altering spin-casting parameters or both. The shape of the undercut regulators 206 will define the resultant pillar profile. The material for the

undercut regulators 206 can be a positive or negative photoresist, which is easily removable by common developer or solvents. Mask pillars 208 are then formed on to the base layer 202 and the undercut regulators 206. The materials of the mask pillars 208 can be UV curable polymers and patterned by standard photolithography. The photoresist is preferably compatible with the preformed undercut regulators 206 to avoid or minimize damage or deformation to the regulators 206 during processing. Alternatively, like the base layer 202, the pillars 208 can be made of oxides, such as SiO_2 , Al_2O_3 and TiO_2 , by sol-gel or vapor deposition and patterned by photolithography and chemical etching. The "I" shaped mask 100 is formed after removing the undercut regulators 206 using developers or solvents.

FIG. 2b shows a typical fabrication process for the "I" shaped mask 150 (FIG. 1b). Starting with a patterned bottom electrode (or anode) 250 formed on a substrate 251, a base layer 252 with pixel windows 254 is formed. The materials of the base layer 252 may be UV curable polymers, such as BCB and polyimide, and patterned by standard photolithography. Alternatively, the base layer 252 can be made of oxides, such as SiO_2 , Al_2O_3 and TiO_2 , by sol-gel or vapor deposition and patterned by photolithography and/or chemical etching. Undercut regulators 256 are then formed on to the base layer 252. The regulators 256 are adjustable in thickness by selecting different photoresists and altering spin-casting parameters or both. The shape of the undercut regulators 256 will define the resultant pillar profile. The material for the undercut regulators 256 can be a positive or negative photoresist, which is easily removable by common developer or solvents.

In particular, for the fabrication process shown in Figure 2b, a first photoresist is initially spin-cast over the base layer 252 and exposed through a mask (not shown) to define openings 253 between main bodies 255 of the undercut regulators 256 after developing. A photoresist 259 of opposite type to the one forming the main body of the undercut regulators 256 is spin-cast over the undercut regulators 256 as a buffer layer and exposed and developed to form openings for deposition of kink portions 257 formed from photoresist of the same type as the main body 255 of the undercut regulators 256. Mask pillars 258 are then formed on to the base layer 252 and the undercut regulators 256. The materials of the mask pillars 258 can be UV curable polymers and patterned by standard photolithography. The photoresist is preferably compatible with the preformed undercut regulators 256 to avoid or minimize damage or deformation to the regulators 256 during processing. Alternatively, like the base layer

252, the pillars 258 can be made of oxides, such as SiO_2 , Al_2O_3 and TiO_2 , by sol-gel or vapor deposition and patterned by photolithography and chemical etching. The "Γ" shaped mask 150 is formed after removing the undercut regulators 256 (together with the kink portion 257 and the buffer layer 259) using developers or solvents.

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FIG. 3a shows a schematic perspective view of a fabricated integrated mask 300 for a passive-matrix OLED device. A plurality of mask strips 302 with "Γ" shape are formed over bottom electrodes 304 on a substrate 306 in an oriented spatial relationship with respect to the bottom electrodes 304 such as an orthogonal spatial relationship.

10 Pixels of light-emitting areas 308 are defined by the intersection between the patterned bottom electrode 304 and a top electrode strip 305, as shown in Figure 3b. The integrated mask 300 is fabricated such that the subsequent deposition layers of organics 307 and of the metallic top electrodes 305 are automatically patterned.

The bottom electrode 304 is deposited onto the substrate 306 and patterned using
15 conventional photolithography and a chemical etching process. Bottom electrode 304 and substrate 306 may be made of conventional materials having conventional dimensions. The substrate 306 can be transparent in the case of bottom- and double-side-emitting devices, such as a glass plate, quartz plate, or a plastic plate, and non-transparent in the case of top-emitting, such as Si wafer, oxide plate, metal sheet, and
20 the like. The substrate 306 can be a flexible substrate such as ultra thin glasses, thin metals, and plastics. The bottom electrodes 304 can be made from a transparent conductor in the case of bottom- and double-side- as well as top-emitting devices, such as conducting polymers, ITO, and other transparent conducting oxides (TCOs), and non-transparent in the case of top-emitting devices, such as metals, and the like.

25 A base layer (not shown) with opening windows for pixels is formed over the bottom electrodes 304 and the substrate 306. The integrated mask 300 with "Γ" shaped strips or pillar 302 is then fabricated on the base layer. One or more organic layers 307(not shown) are then deposited through integrated mask 300 such that the organic layers 307 are electrically connected to the bottom electrodes 304. Organic layers
30 307 may include any conventional OLED organic materials. Organic layers 307 may be a single layer, or may include the multiple layers of conventional OLED structures, such as a single or double heterostructure, or one or more layers containing a mixture of OLED organic materials. The organic layers 307 may be formed by spin-casting, ink-jet printing, vapor deposition, and the like.

A plurality of top electrode strips 305(not shown) are then deposited through integrated mask 300 and over the organic layers 307, such that the top electrodes 305 are electrically connected to the organic layers 307. The top electrodes 305 may be, for example, a vapor deposited electrode made of ITO, Al, Mg, Ca, Ca/Al, Mg:Ag or
5 LiF:Al. Advantageously, a very thin top electrode that is transparent, such that light emitted from organic layers may pass through top electrode to a viewer, in which case device would be a top-emitting OLED.

The resulting device emits light when a current is passed between the bottom electrodes 304 and the top electrode 305, through the organic layers. The device may
10 be a regular bottom-emitting OLED, such that light is emitted through bottom electrode and substrate or a top-emitting OLED, such that light is emitted through top electrode.

The integrated mask 300 is effective for avoiding electrical shorting between electrodes by providing an undercut surface 312 which is parallel to the
15 substrate 306. Further, the integrated mask 300 has practically no limitation to deposition angle, making the integrated mask 300 suitable for mass production. Advantageously, when the mask pillar is made with a groove 313, a dead corner always exists on the bottom surface of the overhang in the mask, which is free of both organic and conducting materials even if severe scattering materials and processes are used for
20 the deposition.

It is to be understood that much larger arrays of organic devices than those specifically described herein may be fabricated. Although FIGs 3a and 3b show a 3x5 array of devices, much larger arrays may be fabricated. Moreover, a multicolor display may be
25 fabricated by depositing various down-conversion layers known to the art, or using different organic materials in different devices. A multi-color array may also be fabricated by a number other methods, such as using an array of white-emitting OLEDs in combination with color filters or a distributed Bragg reflector.

In the following, one specific example of fabricating an integrated mask using a positive
30 photoresist as undercut regulator material and a negative photoresist as pillar material will be described.

AZ4620 positive photoresist, commercially available, is spin coated on to a glass substrate at 2500 rpm for about 40 seconds. The photoresist layer is baked at 105 °C for 5 minutes and then exposed to a 12.5 mW/cm² broad band ultra-violet radiation for 35 seconds through a photo-mask, such that only the portions of photoresist that are to be removed after developing are exposed. The photoresist is then developed in AZ400K, a developer commercially available. The height of the undercut regulator is about 4 microns.

The panel is then coated with a negative photoresist that is compatible with the AZ4620 photoresist for the undercut regulators, such as MF40, at 1000 rpm for 30 seconds, followed by a pre-baking at 75°C for 20 min. The dried negative photoresist with thickness of 0.8 µm functions as buffer layer to protect the undercut regulator from damage during the following processes. Another negative photoresist, such as a diluted solder mask, is spin-coated at 2500 rpm for 60 seconds.

After pre-baking at 75 °C for 30 min, the negative photoresist layers are exposed to ultra-violet radiation from a high pressure mercury lamp operated at a power of 12.5 mW/cm², for 10 seconds through a photo mask, such that only the portions of photoresist that are to remain after exposure are exposed. The exposed negative layers are then developed in an aqueous solution containing 1 to 2% sodium carbonate at room temperature and then in SP 9899 developer to remove the unexposed negative layers, followed by flood UV exposure under the same conditions as the first exposure for at least 10 min.

The dried panel is then put into a bath containing AZ400K and a bath containing acetone to remove the undercut regulators made of positive photoresist, and finally dried in a hot oven at 150°C for 2 hr. As a result, an integrated shadow mask with pillars being of "Γ" shape is ready for device fabrication.

In the following, another specific example of fabricating an integrated mask using a positive photoresist as undercut regulator material, a negative photoresist as a buffer layer material, and another negative photoresist as pillar material, will be described.

AZ4620 positive photoresist, commercially available, is spin-coated on to a glass substrate at 2500 rpm for about 40 seconds. The photoresist layer is baked at 105 °C for 5 minutes and then exposed to a 12.5 mW/cm² broad band ultra-violet radiation for 35 seconds through a photo-mask, such that only the portions of photoresist that are to be

removed after developing are exposed. The photoresist is then developed in AZ400K, a developer commercially available. The dried positive photoresist layer is about 4 μm .

The panel is then coated with a negative photoresist that is compatible with the AZ4620 positive photoresist for the undercut regulators, such as MF40, at 1000 rpm
5 for 30 seconds, followed by a pre-baking at 75°C for 20 min. The dried negative photoresist with thickness of 0.8 μm functions as buffer layer to protect the undercut regulator from damage during the following processes. The negative photoresist layer is then exposed to a 12.5 mW/cm broad band ultra-violet radiation for 60 seconds through a photo-mask, such that only the portions of photoresist that are to
10 remain after developing are exposed. The exposed panel is then developed in SP9899 developer to remove the unexposed negative layers. AZ2001-40 positive photoresist is then spin-coated at 2000 rpm for about 30 seconds. The following steps are the same as for the AZ4620 photoresist described above but using a different photo mask. The resultant two-layer photoresist is to make an undercut regulator for a mask pillar
15 with groove (compare FIG. 1(b)).

Another negative photoresist buffer layer such as MF40 is again used to protect the positive photoresist portion of the regulator and the following procedures are the same as in Example 1.

The described design of an integrated shadow mask can occupy a smaller space and
20 is viable for achieving a higher compared to prior art.

The described methods for fabrication of an integrated mask are specifically suitable for high yield mass production of OLED devices, which is difficult with by existing masks.

The described integrated masks are effective for avoiding electrical shorting between electrodes.

25 Furthermore, the described integrated masks have practically no limitation to deposition angle, and are thus more suitable to mass production than existing masks.

The undercuts and overhangs in the described masks can be accurately regulated through design, using the deposited undercut regulators described. This can provide
30 improvements compared to e.g. undercut techniques relying on etching techniques such as wet-etching formation of undercuts.

The described integrated shadow masks with "Γ" shape can be fabricated in a single material, rather than by multi-layered structures in existing masks.

5 The described mask structure has practically no limitation to deposition angle, materials to be deposited, and vapor deposition process, and thus enables the use of processes that were not previously applicable for top electrode deposition, such as CVD, PVD sputtering with off-axis deposition.

10 It will be appreciated by a person skilled in the art that numerous variations and/or modifications may be made to the present invention as shown in the specific embodiments without departing from the spirit or scope of the invention as broadly described. The present embodiments are, therefore, to be considered in all respects to be illustrative and not restrictive.

15 For example, it is to be understood that the present invention is not limited to the specific passive-matrices described and may be used in a wide variety of other applications. For example, the present invention may be used to fabricate a number of consumer products, including flat panel displays, photodetectors, and arrays of photodiodes.

20 Furthermore, the materials for fabrication of undercut regulators and mask pillars in the integrated mask may be organic, inorganic, as well as hybrid of them. Furthermore, the coating processes used for fabrication of the undercut regulators and pillars in the integrated mask may be wet-coating, vapor deposition, as well as combination of them. In addition, the present invention is not limited to OLED applications, and may be applied to a wide variety of electronic devices. With respect to OLEDs, the present invention is not limited to the particular examples and embodiments described.

CLAIMS

1. An integrated shadow mask comprising:
a substrate;
5 at least one pillar structure having a base portion and an overhang portion supported by the base portion;
wherein the base portion and the overhang portion are formed integrally and the overhang portion includes an undercut surface portion extending from an edge of the overhang portion towards the base portion substantially parallel to or diverging
10 away from a surface of the substrate.
2. The mask as claimed in claim 1, wherein the undercut surface portion comprises a groove.
3. The mask as claimed in claims 1 or 2, wherein the base portion is formed on a base layer formed on the substrate.
- 15 4. The mask as claimed in claim 3, wherein the base layer extends from the base portion to at least a point on the surface of the substrate where a surface normal from the surface is aligned with the edge of the overhang portion.
5. The mask as claimed in any one of the preceding claims, wherein each pillar structure is formed as a strip extending on the surface of the substrate.
- 20 6. The mask as claimed in any one of the preceding claims, further comprising a first electrode layer formed between the surface of the substrate and the base portion of the pillar.
7. The mask as claimed in any one of the preceding claims, wherein the substrate comprises a flexible substrate.
- 25 8. A method of fabricating an integrated shadow mask, the method comprising:
providing a substrate;
forming at least one pillar structure on the substrate, the pillar structure having a base portion and an overhang portion supported by the base portion;
wherein the base portion and the overhang portion are formed integrally and
30 the overhang portion includes an undercut surface portion extending from an edge of the overhang portion towards the base portion substantially parallel to or diverging away from a surface of the substrate.
9. The method as claimed in claim 8, further comprising forming a groove in the undercut surface portion.

10. The method as claimed in claims 8 or 9, further comprising forming a base layer on the substrate, and forming the base portion on the base layer.
11. The method as claimed in claim 10, wherein the base layer extends from the base portion to at least a point on the surface of the substrate where a surface normal from the surface is aligned with the edge of the overhang portion.
12. The method as claimed in any one of claims 8 to 11, wherein each pillar structure is formed as a strip extending on the surface of the substrate.
13. The method as claimed in any one of claims 8 to 12, further comprising forming a first electrode layer between the surface of the substrate and the base portion of the pillar.
14. The method as claimed in any one of claims 8 to 13, wherein forming the pillar structure comprises:
- forming an undercut regulator on the substrate;
 - depositing a pillar material over the undercut regulator; and
 - removing the undercut regulator to release the overhang portion of the pillar structure from the substrate.
15. The method as claimed in any one of claims 8 to 14, wherein the substrate comprises a flexible substrate.
16. A method of fabricating an organic light emitting device utilising the mask as claimed in any one of claims 1 to 7.