

“ACCESSORY MEMBER FOR DISPENSERS OF ALKALI METALS”

The present invention relates to an accessory member for dispensers of alkali metals.

5 It is known that alkali metals have been used for a long time in the electronic field. In particular, a field of application of alkali metals is in the OLED screens (from the definition “Organic Light Emitting Display”).

In brief, an OLED is formed of a first planar transparent support (of glass or plastics); a second support, not necessarily transparent, which can be made in
10 glass, metal or plastics, essentially planar and parallel to the first support and fixed along the perimeter thereof, so as to form a closed space; and a structure active in the image formation in said space. Said active structure is formed of a first series of transparent electrodes, linear and mutually parallel, deposited on the first support; a multilayer of different electroluminescent organic materials, comprising
15 at least one layer of a material conductor of electrons and a layer of a material conductor of electronic vacancies (also defined in the field as “holes”) deposited on the first series of electrodes; a second series of linear and mutually parallel electrodes that are orthogonally oriented with respect to those of the first series and in contact with the opposite side of the multilayer of organic materials in such
20 a manner that the latter is comprised between both series of electrodes. For a more detailed explanation of the structure and the operating principles of OLEDs reference is made, for example, to patent applications EP-A-845924, EP-A-949696, JP-A-9-078058 and to patent US 6,013,384.

Recently it has been found that doping one or more of the organic layers of
25 the OLEDs with small quantities of electron-donating materials, in particular cesium, allows reducing the difference of potential to be applied to the two series of electrodes for the functioning of the screens and therefore the energy consumption of the latter.

For the sake of simplicity, in the present description specific reference will
30 be made to cesium, meaning however also the other alkali metals which have similar applications.

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The doping is carried out by exposing the organic layers of the OLED to cesium vapors in a closed chamber which is maintained under vacuum, in order to avoid that said organic layers, and above all, the second series of electrodes (generally made with metals such as barium) are damaged by the noxious atmospheric agents and in particular by water vapor.

The evaporation of cesium inside the production chamber of the OLED is carried out by using suitable dispensers containing a cesium compound stable to air at room temperature. As a matter of fact, due to its high reactivity towards atmospheric gases and to moisture, cesium is not normally used in the industry as a pure metal. Among these stable compounds, cesium chromate or dichromate can be mentioned which, in mixture with a reducing agent, release cesium as a vapor by heating at temperatures higher than 500 °C. Aluminum, silicon or getter alloys, (i.e. alloys based on titanium or zirconium with aluminum or one or more transition elements) are generally used as reducing agents. The use of these mixtures is described for example in patent US 2,117,735.

Further, cesium dispensers particularly suitable for the production of OLEDs are known from the PCT published patent application WO 02/093664. Said cesium dispensers comprise a container permeable to cesium vapors and containing a mixture of a reducing agent and a cesium compound selected among molybdate, tungstate, niobate, tantalate, silicate and zirconate. These compounds are more advantageous of the previously described ones as they do not contain hexavalent chromium, which can cause irritation by contact, swallowing or inhalation and can be carcinogenic in case of long exposures.

In any case, the dispensers for cesium release are essentially formed of a metal container, heatable by Joule effect, capable of retaining solid particles of the cesium compound. At least one part of their surface is permeable to cesium vapors or provided with small holes or slits through which cesium is emitted in form of vapor. Different shapes of dispensers are subject-matter for example of the patents US 3,578,834, US 3,579,459, US 3,598,384, US 3,636,302, US 3,663,121 and US 4,233,936.

Said dispensers are positioned inside a chamber for the production of

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OLEDs, generally on the bottom thereof, whereas on the ceiling thereof is positioned the substrate on which cesium has to be deposited.

However, a remarkable drawback of the known cesium dispensers consists in that metal evaporation leads to the deposition of cesium not only on the organic
5 layers of the OLED, but on the whole internal surface of the chamber.

Since cesium, as any alkali metal, reacts exothermally with air moisture producing molecular hydrogen, it is desirable to avoid the accumulation of large amounts of metal on the chamber walls which could cause deflagrations at the moment of opening the chamber itself.

10 For this reason, it is necessary to periodically clean the chamber, by passivating the deposited cesium and by removing the same before a large quantity thereof is accumulated. However, this implies the need to stop frequently the manufacturing process in order to open the chamber, carry out these cleaning steps and, before starting again the process, reestablish the vacuum or the inert
15 atmosphere inside the chamber, at the same time carrying out also a baking operation in order to eliminate the traces of moisture which, as above explained, may damage the organic layers of the OLED. Obviously, this implies the need of frequent and long maintenance stops, which are disadvantageous from the point of view of the process economy.

20 Therefore, object of the present invention is to provide an accessory member for dispensers of cesium and other alkali metals, which solves the above mentioned drawbacks. Said object is achieved by means of a screen whose main features are specified in the first claim and other features are specified in the subsequent claims.

25 An advantage of the screen according to the present invention consists in that it allows capturing the cesium vapors in excess, thus preventing the deposit of the cesium on the internal walls of the evaporation chamber, but ensuring a constant and uniform deposit yield on the substrate.

Another advantage of the screen consists in that it can be removed from the
30 inside of the evaporation chamber in a short time and replaced, thus avoiding excessively long maintenance stops.

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An advantage of the screen according to a particular embodiment of the invention consists in that it can be used even when, in the evaporation chamber, the substrate on which the metal has to be deposited is not positioned in front of the cesium dispenser.

5 Further advantages and features of the screen according to the present invention will appear to those skilled in the art from the following description of an embodiment thereof, with reference to the accompanying drawings wherein:

- figure 1 shows in perspective view an example of a known cesium dispenser;
- 10 - figure 2 shows a sectional view along line II-II' of the same dispenser of figure 1;
- figure 3 shows a perspective view of a screen according to a first embodiment of the invention;
- figure 4 shows a perspective view of a screen according to a second
15 embodiment of the invention;
- figure 5 shows a cross-sectional view of the screen of figure 4;
- figure 6 shows a perspective view of a screen according to a third embodiment of the invention.

A known cesium dispenser useable with the screen according to the present
20 invention is shown in figures 1 and 2 in perspective and sectional view respectively; in particular, figure 2 shows the view of the dispenser sectioned along line II-II' of figure 1. Dispenser 10 is formed of two metal sheets, 11 and 12. In the central portion of sheet 12 is provided a cavity, 13, obtained for example by cold moulding of sheet 12. Sheet 11 is provided, in the central portion
25 14 (marked by the dotted line in figure 1) with a series of small holes 15. In the following, portion 14 will be defined as the alkali metals emission zone. In the assembled dispenser, the emission zone 14 is in correspondence with cavity 13; a mixture 16 suitable for releasing by heating an alkali metal is contained in cavity 13; said mixture generally comprises a stable compound of an alkali metal and a
30 reducing agent. Sheets 11 and 12 are fixed to each other, externally to cavity 13, so as to guarantee the tightness for the powders. Dispenser 10 is finally provided

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with two lateral extensions, 17 and 17', useful for the movement with mechanical means in the production line and for the connection to electric terminals for the heating thereof.

The above shown dispenser 10 is only one example of the alkali metals dispensers which can be used with the accessory member according to the present invention; in other embodiments of the invention, the shape of the container and in particular that of the emission zone can be different from the one which is here shown. For example, the emission zone can have a circular shape instead of a rectangular one. Alternatively, the dispenser can be formed of a container having an elongated structure and trapezoidal cross-section, with a longitudinal slit closed by a metal wire which allows cesium evaporation but prevents the powder mixture to come out. Containers of various shapes and materials are known from the previously cited US patents, and are also available on the market, for example from the Austrian company Plansee AG or by the US company Midwest Tungsten Service, Inc.

With reference to figure 3, there is shown that a screen 30 according to the present invention has a substantially tubular shape and defines an internal cavity 33.

The cross-section of said screen can be rectangular, circular or have any other shape in such a way that it can be applied with an end 34 thereof on a alkali metals dispenser. In particular, the cross-section of said end must be superimposable to the whole emission zone of the dispenser, so that the vapors of the alkali metal generated by the dispenser are completely conveyed into the internal cavity of said screen.

Screen 30 according to the present embodiment of the invention has in particular a rectangular cross-section.

The screen according to the present invention must be provided with an internal surface of high specific area. In the present description and claims, the expression "specific area" is intended to mean the ratio between the effective contact area of the surface with the external environment and the geometric area thereof.

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In order to have a high specific area, the internal surface 31 of the screen according to the present invention must have porosities, rugosity or reliefs suitable for capturing the exceeding alkali metal vapors, thus preventing these from depositing on the walls of the evaporation chamber.

5 A further feature of the screen according to the present invention which allows capturing the alkali metal vapors consists in that the portion of contact between said end and said dispenser must be made in a material having low thermal conductivity. In this way, it is possible to avoid that the screen becomes hot due to the contact with the alkali metals dispenser, thus causing the re-
10 evaporation of the alkali metals deposited on the internal surface thereof.

For this purpose, screen 30 can be made completely in a low thermal conductivity material, for example in ceramics.

Alternatively, screen 30 can be made in any material and can comprise spacers 32 made of ceramics or another material having a low thermal
15 conductivity; these spacers may be removable.

Further, since another contribution to the heating of the screen is given by irradiation, the screen can be made of a material which minimizes said effect. For this reason, it is preferably made of a white material.

Another alternative embodiment of the invention is shown in figures 4 and
20 5. In these figures, there is shown that a screen 40 according to the present invention has a circular cross-section, and is therefore particularly suitable for being applied around an emission zone of corresponding shape. Said screen 40 comprises a tubular member 41 made of close-mesh metallic material and an external casing 42 in a material having a low thermal conductivity, for example
25 ceramics.

In this case, the mesh tubular member 41 is provided with an internal surface 43 having a high specific area and allows capturing the exceeding alkali metal vapors, which are emitted by the metal dispenser. The external casing 42 ensures the lateral tightness of the screen, thus preventing those vapors which
30 could pass through the meshes of the tubular member to come out.

Further, as shown in figure 5 the external casing 42 of screen 40 acts also as

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a support for the tubular member 41, thus avoiding the direct contact between the alkali metals dispenser and end 44 of said tubular member, and the consequent heating of the latter.

5 The various embodiments of the invention described above can be used positioning on the bottom of the evaporation chamber the alkali metal dispenser with the screen thereto applied, and on the ceiling of the chamber, exactly above said dispenser, the substrate on which the metal has to be evaporated.

On the contrary a further embodiment of the invention, shown in figure 6, is particularly suitable when the substrate on which the metal has to be evaporated is
10 not positioned exactly above the metal dispenser, but is displaced with respect to this.

As a matter of fact, in this case, it is necessary that the screen according to the present invention intercepts the flow of the alkali metal vapors directed towards the chamber walls, without influencing the part of the vapors directed
15 towards the substrate; the final effect is therefore a net flow directed towards the substrate.

Screen 60 shown in figure 6 is provided with an opening which is oblique or slanting with respect to the axis thereof. Said opening is the one positioned at its end 65 opposite with respect to end 64 for application on the dispenser, and its
20 obliquity allows obtaining a flow of metal vapors having the desired direction. As a matter of fact, it has been found that positioning screen 60 with its higher side farther from the substrate on which the deposit is to be carried out, it is possible to maintain unchanged the efficiency of the metal deposit on the substrate, while reducing the quantity of cesium deposited on the walls.

25 The screen according to the present invention can be simply laid on the alkali metals dispenser, or it can be provided with means for fixing it to said dispenser, for example ceramics hooks.

Alternatively, on the alkali metals dispenser a seat can be provided for the application of a screen according to the invention. Said seat can be formed for
30 example of a recess of shape coincident with that of the lower end of the screen, positioned around its alkali metals emission zone.

CLAIMS

1. Screen (30; 40; 60) of essentially tubular shape, characterized in that it can be applied with an end thereof (34; 44; 64) to an alkali metals dispenser (10),
5 the contact portion between said end and said dispenser being made in a low thermal conductivity material, the cross-section of said end being superimposable to a whole alkali metals emission zone (14) of said dispenser, said screen being provided with an internal surface (31; 43) having a high specific area.
2. Screen according to claim 1, characterized in that it is made of a white
10 material.
3. Screen (30) according to claim 1, characterized in that said portion of contact between said end and said dispenser is formed of one or more spacers (32).
4. Screen according to claim 3, characterized in that said spacers are
15 made of ceramics.
5. Screen according to claim 3 or 4, characterized in that said spacers are removable.
6. Screen (40) according to claim 1, characterized in that it comprises a tubular member (41) made of a close-mesh metallic material and an external
20 casing (42).
7. Screen according to claim 6, characterized in that said external casing is made of ceramics.
8. Screen (40; 60) according to one of the preceding claims, characterized in that it has a circular cross-section.
- 25 9. Screen (60) according to one of the preceding claims, characterized in that the opening at the end thereof (65) opposite to the one (64) where the dispenser is applied is substantially oblique or slanting with respect to the axis thereof.
- 30 10. Screen according to one or more of the preceding claims, characterized in that it is provided with means for fixing to said alkali metals dispenser.

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11. Screen according to one or more of the prededing claims, characterized in that said end thereof (34; 44; 64) to be applied to said alkali metal dispenser has a cross-section corresponding to that of a seat provided in said dispenser around an alkali metals emission zone thereof.