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Datasheet for the decision of 28 March 2019

Case Number: T 1532/14 - 3.4.03

Application Number: 09164876.6

Publication Number: 2144291

IPC: H01L27/32

Language of the proceedings: EN

Title of invention:
Organic light emitting display and method of fabricating the same

Applicant:
Samsung Display Co., Ltd.

Headword:

Relevant legal provisions:
EPC Art. 52(1), 56, 84, 123(2)

Keyword:
Amendments - added subject-matter - main request (yes)
Claims - clarity - main request (no)
Inventive step - auxiliary request (yes)

Decisions cited:

Catchword:

Europäisches Patentamt
European Patent Office
Office européen des brevets

Beschwerdekammern

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Case Number: T 1532/14 - 3.4.03

D E C I S I O N
of Technical Board of Appeal 3.4.03
of 28 March 2019

Appellant: (Applicant)	Samsung Display Co., Ltd. 17113, 1, Samsung-ro Giheung-Gu Yongin-si Gyeonggi-do (KR)
Representative:	Gulde & Partner Patent- und Rechtsanwaltskanzlei mbB Wallstraße 58/59 10179 Berlin (DE)
Decision under appeal:	**Decision of the Examining Division of the European Patent Office posted on 15 April 2014 refusing European patent application No. 09164876.6 pursuant to Article 97(2) EPC.**

Composition of the Board:

Chairman	G. Eliasson
Members:	M. Papastefanou
	T. Bokor

Summary of Facts and Submissions

I. The appeal is against the decision of the examining division refusing the European patent application No. 09 164 876.6 on the grounds that neither the Main request nor the Auxiliary request then on file involved an inventive step within the meaning of Article 56 EPC.

II. After the board issued summons to oral proceedings and its preliminary opinion regarding the requests then on file, the appellant filed a new Main request as well as 1st to 7th Auxiliary requests on 28 February 2019. During the oral proceedings before the board, the appellant filed a new Auxiliary request and withdrew all the other pending Auxiliary requests.

III. The appellant's final requests are that the decision under appeal be set aside and that a European patent be granted on the basis of the Main request filed on 28 February 2019 or on the basis of the Auxiliary request filed in the oral proceedings before the board, the latter having the following version:

> **Description**, pages 1-13 as filed during the oral proceedings before the board;
> **Claims 1-15** as filed during the oral proceedings before the Board, titled "Auxiliary Request";
> **Drawings**: Sheets 1-5 (Figures 1, 2A-B, 3A-D, 4A-D) as originally filed.

IV. The following documents are referred to:

D1: JP 2007-108469 A;
D1a: Automatic English translation of D1 obtained from the website of the Japan Patent Office;

D2: US 2005/0285987 A1.

V. **Claim 1 of the Main request** is worded as follows:

An organic light emitting display comprising:
a plurality of pixels formed on a substrate (200), each pixel comprising a first electrode (240), an organic light emitting layer (250) and a second electrode (255);
wherein the organic light emitting display comprises a plurality of light emitting regions and a plurality of non-light emitting regions, each non-light emitting region being arranged between adjacent ones of the light emitting regions;
wherein each pixel comprises:
a pixel defining layer (245) formed on the first electrode (240); and
a recess (249) formed at a non-light emitting region of the pixel defining layer (245),
wherein the second electrode (255) is formed on the entire surface of the substrate (200) and in the recess (249) as well such that the second electrode (255) includes a portion disposed in the recess (249) on an inner wall of the recess (249), the portion extending along the recess (249) of the pixel defining layer (249),
characterized in that
a conductive material (260) is disposed on the portion of the second electrode (255) in the recess (249) such that the second electrode (255) separates the conductive material (260) from the pixel defining layer (249), wherein the conductive material (260) is a dried conductive ink.

VI. **Claim 9 of the Main request** has the following wording:

A method of fabricating an organic light emitting display comprising: forming a plurality of pixels formed on a substrate (200), each pixel comprising a first electrode (240), an organic light emitting layer (250) and a second electrode (255),
wherein the organic light emitting display comprises a plurality of light emitting regions where an organic light emitting layer (250) is formed such to directly contact a pair of first and second electrodes (240, 255); a plurality of non-light emitting regions where no organic light emitting layer (250) is formed such to directly contact a pair of first and second electrodes (240, 255), each non-light emitting region being arranged between adjacent ones of the light emitting regions;
the method further comprising:
forming a pixel defining layer (245) on the first electrode (240);
forming a recess (249) in a non-light emitting region of the pixel defining layer (245); and forming the second electrode (255) on the entire surface of the substrate (200) and in the recess (249) such that the second electrode (255) includes a portion disposed in the recess (249) on an inner wall of the recess (249), wherein the portion extends along a light emitting region and along a portion in the recess (249);
characterised by
placing a conductive ink (260) on the portion of the electrode (255) in the recess (260) such that the second electrode (255) separates the conductive material (260) from the pixel defining layer (249) and drying the conductive ink (260).

VII. Compared to the Main request, in **claim 1 of the Auxiliary request** the following feature has been added in the end:

"wherein the recess (249) extends as continuous segment along a plurality of pixels."

VIII. Compared to the Main request, in **claim 9 of the Auxiliary request**, it is additionally specified that a recess (249) is formed *as continuous segment along a plurality of pixels in a non-light emitting region of the pixel defining layer (245)* (underlining by the board).

Moreover, the characterising part of the claim is worded as follows (additions underlined, deletions in ~~strike through~~)
"placing a conductive ink (260) on the portion of the electrode (255) in the recess (260) such that the second electrode (255) separates the conductive ~~material~~ ink (260) from the pixel defining layer (249) ~~and drying the conductive ink (260)~~."

IX. With respect to added subject matter in claim 9 of the Main request, the appellant argued that it was self-evident that the claimed method comprised a step of drying the conducting ink since in the final product of the method, i. e. the display of claim 1, the ink was dried.

With respect to inventive step, the appellant argued essentially that although both D1 and the present application addressed the same technical problem, which was the high resistance of the thin layer constituting the common electrode/cathode, the solutions proposed were clearly different. In D1 there was an auxiliary wiring, which was placed under several layers of the display device and was connected intermittently (only at specific points) to the common electrode through the paste P with the connecting members X. In the claimed

display device, there was a recess formed as a continuous segment along a plurality of pixels in the non-light emitting region of the display device. A portion of the cathode electrode extended along this recess and a conductive material (dried ink) was placed in this recess creating, thus, segments with increased conductivity (and lower resistance). Compared to the solution of D1, this was a simpler and easier to implement solution to the same technical problem. The skilled person starting from D1 would find no reason to make any modifications in the display device of D1 since the identified technical problem was already solved therein.

Reasons for the Decision

1. The claimed invention

The claimed invention relates to an organic light emitting display and a method of fabricating it.

In general, light emitting displays or electroluminescence displays are self-luminous displays that comprise fluorescent material(s) which emit light when excited electrically. In organic light emitting displays, the fluorescent material is organic material, which is formed on a glass or other transparent insulating substrate. An anode and a cathode electrode, which provide the electrical excitation to the fluorescent organic material, are formed on the upper and lower sides of the organic light emitting layer (see also paragraphs [0003] to [0006] of the application as published).

Depending on the direction in which light is emitted

the display is a top emission type (when light is emitted from the upper side) or bottom emission type (light emitted from the lower side) or both. The top emission type is more suitable for displays of bigger sizes and has become the most commonly used type (see paragraph [0015]).

In top emission type displays, the cathode electrode is placed on top of the organic emitting layer. In order to guarantee a good quality of the display, the cathode electrode has to be transflective, i.e. it has to be able both to transmit and to reflect light. In order to achieve these properties, the cathode electrode is formed as a thin layer on the organic light emitting layer. This layer, however, has high electrical resistance, which causes significant voltage drop across the cathode electrode, when current is supplied through the electrode in order to excite the light emitting layer. This voltage drop results in inconsistent excitation voltage across the electrode layer causing non-uniform luminance of the display (see paragraphs [0017] to [0020]).

This problem is usually addressed by using means to increase the conductivity of the cathode electrode layer (i.e. decrease its resistance) so that voltage drop across the electrode is minimised. The solution of the claimed invention consists in forming recesses in the display layers as continuous segments extending over a plurality of pixels. Portions of the cathode electrode extend in these recesses and a conductive material (conductive ink), which has lower resistance (higher conductivity) than the cathode electrode layer, is placed in them. In this way, on the surface of the cathode electrode there are segments of dried conductive ink which function as additional wiring

which has a higher conductivity (lower resistance) than the electrode layer (see Figure 4A). As a result, the overall conductivity of the cathode electrode layer is increased (overall resistance is decreased), minimising the voltage drop across the cathode electrode and improving, thus, the uniformity of the luminance of the display.

2. Main request

2.1 The method defined in claim 9 of the Main request comprises the step of *drying the conductive ink* (see last line of the claim).

2.2 It is uncontested that there is no explicit disclosure of such a step in the method described in the originally filed application.

2.3 The appellant made reference to claim 1 of the current Main request and to claim 7 as originally filed and pointed out that the conductive material in the claimed organic light emitting display was dried conductive ink (see last feature of claim 1 of the Main request). This conductive ink was disposed in the recess by inkjet printing in a liquid state. Since the ink was dried in the final product of the method (the organic light emitting display), it was self-evident that the ink had to be dried at some stage of the fabricating method. The skilled person would understand, thus, that the claimed method included implicitly a step of drying the conductive ink after it was placed on the portion of the (second) electrode in the recess. The claimed method step was, therefore, implicitly disclosed in the originally filed application and the subject-matter of claim 9 fulfilled the requirements of Article 123(2)

EPC.

2.4 The board acknowledges that the skilled person would understand that the conductive ink in the organic emitting display (of claim 1), which is the final product of the method defined in claim 9, must be dried, not only because it is so defined in claim 1 but also because it does not make sense to have a display according to the claimed invention with liquid ink as conductive material.

However, it is also a fact that the originally filed application does not provide any information or indication as to how the conductive ink is (to be) dried after it is placed on the portion of the electrode in the recess. It is possible for example that the liquid ink is simply left to dry by itself. Alternatively, it is equally possible that the ink is heated in order to dry, as it is known in the state of the art and is described for example in D2 (see paragraph [0096]). Since there is not only one way of obtaining the dried conductive ink of claim 1, the board cannot see the step of drying the conductive ink as implicitly disclosed in the originally filed application, as the appellant argued.

2.5 The board agrees with the appellant that drying the conductive ink might be an obvious step for the skilled person in the context of the present application. However, the question to ask in the assessment of compliance with the requirements of Article 123(2) EPC is whether the skilled person would derive this method step from the originally filed content of the application, directly and unambiguously and using common general knowledge (i.e. the so-called "gold standard"; see also *Case Law of the Boards of Appeal of*

the European Patent Office, II.E.1.2.1, 1.2.2 and 1.2.3).

The board cannot find any basis in the originally filed application for such a method step and the appellant has not indicated any, either. In particular, in the description of the process (method) of fabricating an organic emitting display there is no disclosure or suggestion of any step of drying the conductive ink (see paragraphs [0066] to [0076] and Figures 3A to 3D of the originally filed/published application).

The board concludes, hence, that the subject-matter of claim 9 of the Main request does not meet the requirements of Article 123(2) EPC.

2.6 In addition, in the characterising part of claim 9 (see point VII. above) there is an inconsistency in the use of the terms "conductive ink" and "conductive material". According to the characterising part of the claim, the method comprises the step of "***placing a conductive ink*** *(260) on the portion of the electrode (255) in the recess (260) such that the second electrode (255)* ***separates the conductive material...***" (emphasis added). The term "conductive material" has no antecedent in the claim and it is not clear which conductive material it refers to because of the previous definition of the use (placing) of a conductive ink.

2.7 This inconsistency renders the claim unclear, against the requirement of clarity according to Article 84 EPC.

2.8 The board concludes, thus, that claim 9 of the Main request does not fulfill the requirements of Articles

84 and 123(2) EPC.

3. Auxiliary request

3.1 Amendments

3.1.1 The feature added to independent claims 1 and 9 of the Auxiliary request with respect to the Main request, according to which *the recess (249) extends as continuous segment along a plurality of pixels*, finds basis in paragraph [0078] of the originally filed (published) application (see also Figure 4A).

3.1.2 The step of drying the conductive ink has been deleted from claim 9. The objection under Article 123(2) EPC against the Main request has thus become moot.

3.1.3 In a further amendment to claim 9, the term "conductive material" has been replaced with "conductive ink", overcoming thus the objection of lack of clarity against claim 9 of the Main request.

3.1.4 The description has been adapted to the claims of the Auxiliary request and documents D1 and D2 are cited therein (see paragraph [0019]).

3.1.5 The board is thus satisfied that the requirements of Rule 42 EPC as well as those of Articles 84 and 123(2) EPC are met.

3.2 Inventive Step (Articles 52(1) and 56 EPC)

3.2.1 It is common ground that D1 represents the closest prior art (the passage references hereafter refer to D1a, the references to Figures to D1).

In the terminology of claim 1, D1 discloses an organic light emitting display (see Figure 1(a) and paragraph [0018]) comprising a plurality of pixels (3) formed on a substrate (2). Each pixel comprises (see Figure 1(b) and paragraphs [0020]-[0021]) a first electrode (picture element electrode 14), an organic emitting layer (consisting of the layers 18, 19, 20) and a second electrode (common electrode 21). The organic light emitting display (see Figure 1(a)) comprises a plurality of light emitting regions (pixels 3) and a plurality of non-light emitting regions, each non-light emitting region being arranged between adjacent ones of the light emitting regions (non-light emitting regions between the pixels 3, see also Figure 1(b)). Each pixel comprises further a pixel defining layer (bank/second barrier layer 17) formed on the first electrode (picture element electrode 14), a recess formed at a non-light emitting region of the pixel defining layer (see Figure 1(b), recess located above the driving TFT 5, adjacent to the pixel area), wherein the second electrode (common electrode 21) is formed on the entire surface of the substrate (see paragraph [0021]) and in the recess, wherein a conductive material is formed on the portion of the second electrode (common electrode 21) in the recess (paste P with connecting members X; see paragraphs [0021] and [0025]).

3.2.2 The board is of the opinion that D1 discloses also that the second electrode (common electrode 21) comprises a portion on an inner wall of the recess of the pixel defining layer (bank 17) which separates the conductive material (P, X) from the pixel defining layer (bank 17).

In the decision under appeal, the examining division referred to Figure 4 of D1 and concluded that the

common electrode 21 was formed on an inner wall of the recess, extended along the recess of the bank 17 and separated the conductive material (P, X) from the bank 17.

The board notes, however, that Figure 4 presents a step in the fabricating process of the organic light emitting display of D1. According to the described method (see paragraphs [0032] and [0033]), the paste P containing the connecting members X is disposed on the common electrode 21 and then pressure is applied to the paste P so that it is driven in through the common electrode 21 up to the auxiliary wiring 4. The board understands that the device described in Figure 4 is not (yet) the organic light emitting display described in D1 since the last step of the fabricating process has not been executed at that point yet. Only after pressure is applied to the paste P, the paste (with the connecting members X) is driven through the common electrode 21 and connected to the auxiliary wiring 4, the display, shown in Figures 1(a) and 1(b) is obtained. In other words, Figure 4 shows only the device at an intermediate stage during the fabricating process and not the organic light emitting display according to D1.

At the same time, the board is of the opinion that the representation of the light emitting display in Figure 1(b) is not entirely accurate. Taking into account the situation after the paste P with the connecting members X is disposed on the common electrode 21 but before it is pressed and driven through it (as shown in Figure 4), applying pressure to the paste P would cause the common electrode 21 to break at its lowest point in the recess; it would not destroy and remove completely the portion(s) of the common electrode 21 formed on the

inner walls of the recess as shown in Figure 1(b), where the common electrode 21 is completely removed from the recess. It would rather create a form of a funnel in which the common electrode 21 would still comprise portions on the inner walls of the recess but would have a hole in the middle, at the lowest point of the recess, where the paste P (with connecting members X) would be driven through.

Therefore, although the common electrode 21 would not be extending along the recess (because there would be a hole at the lowest point), it would have (a) portion(s) on the inner wall(s) of the recess which separate the conductive material (P, X) from the pixel defining layer (bank 17).

3.2.3 A point of discussion was whether the recess in D1 extended as a continuous segment along a plurality of pixels or not. Both the appellant and the examining division in the impugned decision (see point 2.4.1) considered that the recess in the bank 17 of the display in D1 was intermittent, i. e. it was not extending along a plurality of pixels but had the form of holes at specific points of the display. The board was of the preliminary opinion that the recess on the bank 17 of D1 was extending as a continuous segment over a plurality of pixels in the same way as in the claimed display (see point 3.2 of the board's communication).

After discussion during the oral proceedings, the board reversed its preliminary opinion and agreed with the opinion of appellant and the examining division regarding the form of the recess in D1.

Although the conductive material (P, X) is applied on

the common electrode continuously (see Figures 1(a) and 6 as well as paragraphs [0021] and [0033]), there is no explicit disclosure in D1 of a recess extending over a plurality of pixels in which the conductive material is placed. The fact that the conductive material is only intermittently (i.e. at specific points - see Figure 6) driven through the electrode in order to provide a connection with the auxiliary wiring 4 suggests that a continuous recess in the pixel defining layer/bank 17 is not necessary in the display of D1. Based on the presentation of the display in Figure 6, the board understands that the paste P is continuously applied on the common electrode 21, but apart from the points where it is driven through the electrode in order to connect with the auxiliary wiring 4, it is placed on the (flat) surface of the common electrode and not in any recess. According to the disclosure of D1, a recess is formed at the point(s) where the paste is driven (pressed) through the common electrode but neither in the Figures nor in the description of D1/D1a is there any indication that the recess extends over a plurality of pixels.

Moreover, the conductive material in D1 (paste P with connecting members X), although it has to have some viscosity, is not to be understood as a liquid since it has to be pressed through the common electrode 21 in order to form the connection to the auxiliary wiring 4, something that would be practically impossible to achieve with a liquid conductive material (like ink). If the conductive material (P, X) is not liquid, there is no risk of it spilling over if it is placed on the flat surface of the common electrode 21, i. e. outside of any recess. It is, therefore, plausible that the recess shown in Figure 1(b) has the form of a hole in the pixel defining layer/bank 17 rather than a

continuous segment extending over a plurality of pixels like in the claimed organic light emitting display.

3.2.4 Summarising, the display of claim 1 differs from the one in D1 in that:

- the second electrode has a portion extending along the recess of the pixel defining layer;
- the recess extends as continuous segment along a plurality of pixels; and
- the conductive material is dried conductive ink.

3.2.5 These differentiating features allow the implementation of the solution to the technical problem of how to provide a more uniform luminance of a top emission organic light emitting display according to the present application.

The claimed organic light emission display comprises a continuous recess along which a portion of the second (common) electrode extends. This recess contains a dried conductive ink (see Figure 4A of the application). This dried conductive ink provides a form of auxiliary/additional wiring which has higher conductivity (lower resistance) than the second electrode layer and which increases, thus, the overall conductivity of the second electrode (or decreases its resistance). As explained previously, increasing the conductivity of the second electrode reduces the voltage drop across it and improves the uniformity of the luminance of the display.

3.2.6 In D1 the same technical solution (increasing the conductivity of the common electrode) of the same technical problem (how to improve the uniformity of the luminance of the display) is implemented in a different way.

An auxiliary wiring 4 is located under the recess of the pixel defining layer (bank 17 - see Figure 1(b)) in the non-light emitting region of the display (see Figure 1(a)). The conductive material, consisting of a paste P with connecting members X, is placed on the portion of the common (second) electrode 21 within the recess and is driven (pressed) through the common electrode 21, providing thus an electric connection between the auxiliary wiring 4 and the common (second) electrode 21. The connection between the common (second) electrode 21 and the auxiliary wiring 4 (which has higher conductivity/lower resistance than the common electrode 21) increases the overall conductivity of the common (second) electrode.

3.2.7 Comparing the two solutions, the claimed organic light emitting display has the advantages of being simpler and easier to implement, since neither the auxiliary wiring located under the pixel defining layer nor the connection of the second (common) electrode to it is necessary. The auxiliary wiring in the claimed display is effectively formed by the dried conductive ink in the recess(es), is located on the upper surface of the display and can be formed in a relatively simple and fast manner since no additional connections to underlying layer(s) are necessary.

3.2.8 The skilled person starting from D1 is, thus, faced with the technical problem of how to provide an alternative, simpler way to increase the conductivity of the second (common) electrode of the organic light emitting display.

3.2.9 There is nothing in D1 that would point the skilled person towards the display of claim 1 of the Auxiliary

request.

The skilled person would have to undertake a series of modifications in the display of D1, like for example the forming of a recess as a continuous segment over a plurality of pixels, the use of a different conductive material instead of a paste and the dispensing of the connection to the auxiliary wiring 4. Such modifications would go against the whole concept of the invention according to D1 and would therefore require the exercising of inventive skill by the skilled person.

The board is, thus, of the opinion that the subject-matter of claim 1 involves an inventive step within the meaning of Article 56 EPC. The same applies to the subject-matter of claim 9, which defines the corresponding fabricating method and which comprises corresponding distinguishing features.

4. Summarising, the board concludes that the Main request does not meet the requirements of Articles 84 and 123(2) EPC and that the Auxiliary request and the invention to which it relates meet the requirements of the EPC. Hence, a European patent is to be granted under Article 97(1) EPC based on the Auxiliary request.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the examining division with the order to grant a patent in the following version:

Description, pages 1-13 as filed during the oral proceedings before the board;
Claims 1-15 as filed during the oral proceedings before the board, titled "Auxiliary Request"; and
Drawings: Figures 1, 2A-B, 3A-D, 4A-D as originally filed.

The Registrar: The Chairman:

S. Sánchez Chiquero G. Eliasson

Decision electronically authenticated