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Case Number: T 1659/09 - 3.4.03

Application Number: 02077318.0

Publication Number: 1246269

IPC: H01L 51/20, H01L 27/00

Language of the proceedings: EN

Title of invention:
Electroluminescent device

Applicant:
Cambridge Display Technology Limited

Headword:
-

Relevant legal provisions:
EPC Art. 54(3), 123(2)

Relevant legal provisions (EPC 1973):
EPC Art. 54(1)(2)(4), 56

Keyword:
"Inventive step (no)"
"Amendments - undisclosed disclaimer, added subject-matter (yes)"

Decisions cited:
G 0001/03, T 0793/93, T 0204/00

Catchword:
-

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Case Number: T 1659/09 - 3.4.03

D E C I S I O N
of the Technical Board of Appeal 3.4.03
of 11 April 2013

Appellant: (Applicant)
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Decision under appeal: **Decision of the Examining Division of the European Patent Office posted 31 March 2009 refusing European patent application No. 02077318.0 pursuant to Article 97(2) EPC.**

Composition of the Board:

Chairman: G. Eliasson
Members: R. Q. Bekkering
T. Karamanli

Summary of Facts and Submissions

I. This is an appeal against the refusal of application No. 02 077 318 for lack of novelty, Article 54(1), (3) and (4) EPC (main request then on file) over document

D2: WO 97 32452 A,

for added subject-matter, Article 123(2) EPC (first and third auxiliary request then on file), and for lack of an inventive step, Article 56 EPC (second auxiliary request then on file) over document

D1: WO 96 31909 A.

II. In the board's communication under Article 15(1) RPBA, reference was also made to document

D3: US 5 317 169 A,

cited in document D2, page 3, lines 14 to 17.

III. The appellant requested at oral proceedings before the board that the decision under appeal be set aside and that a patent be granted on the basis of the claims

according to the main request or one of the first to third auxiliary requests, all filed with the statement of the grounds of appeal, or

according to one of the fourth and fifth auxiliary requests, both filed with letter dated 4 March 2013, or

according to the sixth auxiliary request, filed in the oral proceedings of 11 April 2013.

IV. Claim 1 according to the main request reads as follows:

"*An electroluminescent device comprising:*
a first charge-carrier injecting layer for injecting positive charge carriers and a second charge-carrier injecting layer for injecting negative charge carriers, at least one of the charge-carrier injecting layers being patterned so as to comprise spaced-apart charge-injecting regions;
an organic light-emitting layer located between the first and second charge-carrier injecting layers; and
an unpatterned conductive polymer layer located between the organic light-emitting layer and the patterned charge-carrier injecting layer, the resistance of the conductive polymer layer being sufficiently low to allow charge carriers to flow through it from the charge-injecting regions to generate light in the organic light-emitting layer and the sheet resistance of the conductive polymer layer being greater than 10^6 Ohms/square so as to resist lateral spreading of charge carriers beyond the charge-injecting regions."

V. Claim 1 according to the first auxiliary request corresponds to claim 1 of the main request, with the following addition:

"*excluding electroluminescent devices wherein the unpatterned conductive polymer layer comprises polyaniline emeraldine salt*".

VI. Claim 1 according to the second auxiliary request corresponds to claim 1 of the first auxiliary request, with the following addition:

"*wherein the electroluminescent device is a two electrode device*".

VII. Claim 1 according to the third auxiliary request corresponds to claim 1 of the second auxiliary request, with the following addition:

"*wherein the unpatterned conductive polymer layer has a thickness less than 100nm*".

VIII. Claim 1 according to the fourth auxiliary request corresponds to claim 1 of the main request, with the following addition:

"*wherein the electroluminescent device is a two electrode device*".

IX. Claim 1 according to the fifth auxiliary request corresponds to claim 1 of the fourth auxiliary request, with the following addition:

"*wherein the unpatterned conductive polymer layer has a thickness less than 100nm*".

X. Claim 1 according to the sixth auxiliary request corresponds to claim 1 of the main request, however, wherein the last feature of the claim reads (amendment highlighted):

"*the sheet resistance of the conductive polymer layer being greater than* ***10^8*** *Ohms/square so as to resist lateral spreading of charge carriers beyond the charge-injecting regions*".

XI. The appellant in substance provided the following arguments:

Document D3 provided no direct and unambiguous disclosure of a conductive polymer layer having a sheet resistance of greater than 10^6 Ohms/square. In order to provide a novelty-destroying disclosure the skilled person would have needed to have combined one particular value of the layer thickness with a particular value for electrical conductivity of the layer from separate passages of the disclosure and in a further step combine these parameters using the above equation to arrive at a value for the sheet resistance. Even if the skilled person had considered combining the disclosed range of conductivity with a value for layer thickness in order to arrive at a value for sheet resistance, the skilled person would not have inevitably arrived at a value of greater than 10^6 Ohms/square as he could have taken other thicknesses disclosed in D3. Moreover, document D3 did not provide a patterned charge-carrier injecting layer and was not concerned with resisting lateral spreading of charge carriers beyond charge-carrier injecting regions and blurring of the display image. Thus, the skilled person would not have been motivated to consider the sheet resistance of the polymer layer, and would therefore not be taught to combine the parameters of conductivity and layer thickness.

Accordingly, the claims of the main request were both novel and involved an inventive step.

Claim 1 of the first to third auxiliary request included a disclaimer excluding electroluminescent devices wherein the unpatterned conductive polymer layer comprised polyaniline emeraldine salt. This disclaimer was intended to confer novelty over D2 (which was prior art under Article 54(3) and (4) EPC) and as such, an allowable unsupported disclaimer in accordance with the decision of G 1/03. Moreover, claim 1 of the second and third auxiliary request included additional limitations to a two electrode device and a layer thickness of less than 100nm, providing further distinctions over the prior art. Accordingly, also the claims of the first to third auxiliary request were both novel and involved an inventive step.

Claim 1 of the fourth and fifth auxiliary request corresponded to claim 1 of the second and third auxiliary request, with the further amendment to delete the disclaimer objected to by the board. Claim 1 of the sixth auxiliary request was restricted to a sheet resistance of greater than 10^8 Ohms/square and thus further distinguished over the prior art. Accordingly, also the claims of the fourth to sixth auxiliary request were both novel and involved an inventive step.

Reasons for the Decision

1. The appeal is admissible.

2. *Main request*

2.1 *Novelty, inventive step*

Since document D3 is pre-published prior art in accordance with Article 54(2) EPC 1973, as opposed to document D2 which is considered as comprised in the state of the art in accordance with Article 54(3) EPC and Article 54(4) EPC 1973, it is considered expedient to consider document D3 first.

2.2 *Novelty*

Document D3 relates to an organic electroluminescence device, which can be easily fabricated and used as a large area light emitting device for various displays. The device comprises a light emitting layer and a charge transport layer disposed between a pair of electrodes, the charge transport layer comprising a conducting polymer (cf abstract; column 1, lines 9 to 13; column 7, line 37 to column 8, line 33; figure 2).

In particular, document D3 discloses, in the terms of claim 1, an electroluminescent device comprising:
a first charge-carrier injecting layer for injecting positive charge carriers and a second charge-carrier injecting layer for injecting negative charge carriers (2, 4);
an organic light-emitting layer (3) located between the first and second charge-carrier injecting layers; and

an unpatterned conductive polymer layer (5) located between the organic light-emitting layer and charge-carrier injecting layer (2).

Moreover, according to D3, when the light emitted is to be taken out from the conducting polymer side of the EL device, the electrical conductivity of the conductive polymer is preferably 0.1 S/cm or less (column 7, lines 23 to 36; claim 1).

The thickness of the conductive polymer layer is for instance 100 Å. In fact, as can be seen from the specific examples in table 1, the best results are obtained with a conductive polymer layer of polyaniline with a thickness of 100 Å (example 11) (cf column 17, table 1).

The sheet resistance of a conductive polymer layer having a thickness t of 100 Å and an electrical conductivity σ of 0.1 S/cm or less, using

$R_s = 1/\sigma t$

is 10^7 Ohm/square or more.

Accordingly, the conductive polymer layer according to example 11 has a "*sheet resistance* [...] *being greater than* 10^6 *Ohms/square*" as per claim 1.

The appellant argued that D3 provided no direct and unambiguous disclosure of a conductive polymer layer having a sheet resistance of greater than 10^6 Ohms/square. It was clear that there was no explicit disclosure of this sheet resistance in D3. Following

the EPO Guidelines for Examination Part G, Chapter VI, section 6, "*an objection of lack of novelty of this kind should be raised by the examiner only where there can be no reasonable doubt as to the practical effect of the prior teaching*". However, there was reasonable doubt as to the practical effect of the disclosure of D3. In order to provide a novelty-destroying disclosure the skilled person would have needed to have combined one particular value of the layer thickness with a particular value for electrical conductivity of the layer from separate passages of the disclosure and in a further step combine these parameters using the above equation to arrive at a value for the sheet resistance. For an implicit disclosure to be novelty destroying the skilled person had to inevitably arrive at a result falling within the terms of the claim. Even if the skilled person had considered combining the disclosed range of conductivity with a value for layer thickness in order to arrive at a value for sheet resistance the skilled person would not have inevitably arrived at a value of greater than 10^6 Ohms/square. For example, instead of taking the value of 100 Å as proposed by the Board the skilled person could equally have taken a value of 1 µm, leading to a sheet resistance of 10^5 Ohms/square for a conductivity of 0.1 S/cm, or 10 µm, leading to a sheet resistance of 10^4 Ohms/square, outside of the claimed range. Reference was also made to decisions T 793/93 and T 204/00 as cited in the Case Law of the Boards of Appeal, 6th edition, 2010, page 560.

The board, however, cannot agree with the above arguments. According to document D3, the electrical

conductivity of the conductive polymer layer is 0.1 S/cm or less (cf column 7, lines 23 to 36; claim 1). In particular, it is disclosed in D3 that "*it is known that the conducting polymer of the general formula (2) has an increased electrical conductivity when doped with impurities such as sulfuric acid, iodine, iron (II) chloride, etc. It is also known that, in the state in which the electrical conductivity is increased as described above, absorbance in a visible wavelength region is also increased and optical transmittance is greatly reduced to lose transparency. Therefore, the doping is not preferably carried out when a light emitted is to be taken out from the conducting polymer side of the EL device. Since the absorption spectrum correlates with the electrical conductivity, the electrical conductivity is preferably 0.1 S/cm or less*". Conductivity values outside the range of 0.1 S/cm or less are in fact not disclosed in D3 and only this range is claimed in D3.

As to the thickness of the conductive polymer layer, document D3 discloses, with respect to the embodiment of figure 2 of relevance in the present case, "*for example, 50 angstroms to 10 micrometers and preferably 100 angstroms to 1 micrometer to increase a current density so as to increase a light emitting efficiency*" (column 8, lines 12 to 21). Moreover, as pointed out above, a number of specific examples are provided (see table 1) in which example 11 with a layer thickness of 100 Å is indicated to provide the best results in terms of the uniformity of the emitted light.

Accordingly, a conductive polymer layer having a thickness of 100 Å and a conductivity of 0.1 S/cm or less is an embodiment of document D3.

It is noted that, contrary to what the appellant's arguments would appear to suggest, in D3 no selection from two or more lists of a certain length has to be made in order to arrive at the specific combination of thickness and conductivity, leading to the sheet resistance value claimed (ie a selection according to the "*two-lists principle*"). In fact, for a thickness of eg 100 Å as discussed above, the entire range of disclosed conductivities of 0.1 S/cm or less results in a sheet resistance falling within the claimed range. Accordingly, for the conductivity there is no selection from a list. Even for the thickness of the layer, it is doubtful whether a selection from a list in the sense of the above two-lists principle is present, as in D3 the specific thickness of 100 Å is highlighted as producing a device with the best light-emitting properties (table 1, caption).

Neither can it be held that in a further step the skilled person would have to "*combine*" these parameters using an equation to arrive at a value for the sheet resistance. What is required in the present case in order to arrive at the claimed value for the sheet resistance, is the mere conversion, using a standard equation, of the physical quantities (electrical conductivity and thickness) used in D3 to define the physical properties of the conductive polymer layer into the physical quantity (sheet resistance) used in claim 1 of the present application.

Furthermore, it is noted that both the "*practical effect of the prior teaching*", as mentioned in the Guidelines for Examination in the EPO, and in the decisions T 793/93 and T 204/00 referred to by the appellant, relate to the case where it cannot be determined with certainty that the outcome of a prior art teaching, for instance a manufacturing process, leads to eg a particular parameter value falling within the terms of the claim, as not all conditions are specified. This has, however, no bearing on the present case, as no uncertainty exists as to what might or might not be the result of carrying out the prior art teaching. In fact, the thicknesses and conductivities of the conductive polymer layer are unambiguously specified in D3, and with that the resulting sheet resistance of the layer.

Moreover, the appellant's argument that other thickness disclosed in D3, in combination with a conductivity of 0.1 S/cm, would provide sheet resistances falling outside the claimed range is of no relevance, as for lack of novelty it is not a prerequisite that all embodiments of the prior art fall within the claimed subject-matter.

In document D3, however, neither of the first and second charge-carrier injecting layers (2, 4) is "*patterned so as to comprise spaced-apart charge-injecting regions*" as defined in claim 1.

Accordingly, the subject-matter of claim 1 of the main request is new over document D3 (Article 54(1) EPC 1973).

2.3 *Inventive step*

As discussed above, the subject-matter of claim 1 differs from document D3 in that at least one of the charge-carrier injecting layers is patterned so as to comprise spaced-apart charge-injecting regions.

The effect of hereof is that the electroluminescent device can produce a patterned image.

In view of the above, the objective problem to be solved relative to D3 is to make the organic electroluminescent device of D3 suitable for displaying a patterned image.

However, as also acknowledged by the appellant, patterning is common in organic electroluminescent devices. Moreover, it would be obvious to a person skilled in the art working in the field at issue of electroluminescent devices, to pattern at least one of the charge-carrier injecting layers so that it comprises spaced-apart charge-injecting regions providing the desired patterned image.

The appellant argued that document D3 did not provide a patterned charge-carrier injecting layer and was not concerned with resisting lateral spreading of charge carriers beyond charge-carrier injecting regions and blurring of the display image. Thus, the skilled person would not have been motivated to consider the sheet resistance of the polymer layer, and would therefore not be taught to combine the parameters of conductivity and layer thickness in the manner suggested by the board. In fact, document D3 was concerned with the

uniformity of the display (cf eg column 2, lines 19 to 22). Accordingly, it was not a suitable starting point for an assessment of inventive step.

It is however noted that also with a patterned charge-carrier injecting layer, applying the teaching of document D3 regarding the conductive polymer layer, ie providing a layer of 100 Å with a conductivity of 0.1 S/cm or less, results in a conductive polymer layer with a sheet resistance within the claimed range and which, consequentially, adequately resists lateral spreading of charge carriers beyond charge-carrier injecting regions and prevents blurring of the display image. Moreover, it is noted that the uniformity of the light emission of the organic electroluminescence display device, the light emitting efficiency and luminance addressed in D3 are equally important properties for a display device providing a patterned image. Since in D3 the conductive polymer layer, in particular its conductivity and thickness, is selected so as to optimise these properties, it would be obvious to the skilled person to use the same conductive polymer layer for a display device providing a patterned image.

The subject-matter of claim 1 according to the main request, thus, lacks an inventive step in the sense of Article 56 EPC 1973.

Accordingly, the appellant's main request is not allowable.

3. *First auxiliary request*

Claim 1 according to the first auxiliary request includes with respect to claim 1 of the main request the following addition:

"*excluding electroluminescent devices wherein the unpatterned conductive polymer layer comprises polyaniline emeraldine salt*".

The above addition to claim 1 is an undisclosed disclaimer intended to confer novelty over D2, which is considered as comprised in the state of the art under Article 54(3) EPC and Article 54(4) EPC 1973.

However, according to G 1/03 (OJ EPO 2004, 413) "*a disclaimer which is or becomes relevant for the assessment of inventive step [...] adds subject-matter contrary to Article 123(2) EPC*" (cf order 2.3).

Since in the present case the subject-matter of claim 1, disregarding the disclaimer, lacks an inventive step for the reasons given above for the main request, the disclaimer becomes relevant for the assessment of inventive step of the subject-matter of claim 1 according to the first auxiliary request and thus, in accordance with G 1/03 above, adds subject-matter contrary to Article 123(2) EPC.

Accordingly, the appellant's first auxiliary request is not allowable.

4. *Second auxiliary request*

Claim 1 according to the second auxiliary request corresponds to claim 1 of the first auxiliary request, with the following addition:

"*wherein the electroluminescent device is a two electrode device*".

However, the device of document D3 is a two-electrode device. The subject-matter of claim 1 according to the second auxiliary request, disregarding the disclaimer, thus, also lacks an inventive step.

Accordingly, the disclaimer becomes relevant for the assessment of inventive step of the subject-matter of claim 1 according to the second auxiliary request and thus, in accordance with G 1/03 above, adds subject-matter contrary to Article 123(2) EPC.

The appellant's second auxiliary request is, therefore, not allowable.

5. *Third auxiliary request*

Claim 1 according to the third auxiliary request corresponds to claim 1 of the second auxiliary request, with the following addition:

"*wherein the unpatterned conductive polymer layer has a thickness less than 100nm*".

However, document D3 discloses, as discussed above, for instance a thickness of 100 Å (10nm) for the conductive

polymer layer, falling in the claimed range. The subject-matter of claim 1 according to the third auxiliary request, disregarding the disclaimer, thus, also lacks an inventive step.

Accordingly, also in this case the disclaimer becomes relevant for the assessment of inventive step of the subject-matter of claim 1 and thus, in accordance with G 1/03 above, adds subject-matter contrary to Article 123(2) EPC.

The appellant's third auxiliary request is, thus, not allowable either.

6. *Fourth auxiliary request*

Claim 1 according to the fourth auxiliary request corresponds to claim 1 of the main request, with the following addition:

"*wherein the electroluminescent device is a two electrode device*".

However, as discussed above for the second auxiliary request, the device in document D3 is a two-electrode device. Accordingly, the subject-matter of claim 1 according to the fourth auxiliary request lacks an inventive step.

The appellant's fourth auxiliary request is, therefore, not allowable.

7. *Fifth auxiliary request*

Claim 1 according to the fifth auxiliary request corresponds to claim 1 of the fourth auxiliary request, with the following addition:

"*wherein the unpatterned conductive polymer layer has a thickness less than 100nm*".

As discussed above for the third auxiliary request, however, document D3 discloses for instance a thickness of 100 Å (10nm) for the conductive polymer layer, falling in the claimed range.

Accordingly, the subject-matter of claim 1 according to the fifth auxiliary request also lacks an inventive step in the sense of Article 56 EPC 1973.

The appellant's fifth auxiliary request is, therefore, not allowable either.

8. *Sixth auxiliary request*

Claim 1 according to the sixth auxiliary request corresponds to claim 1 of the main request, however with the sheet resistance of the conductive polymer layer being defined to be greater than $\mathbf{10^8}$ Ohms/square.

As noted above for the main request, according to document D3 "*it is known that the conducting polymer of the general formula (2) has an increased electrical conductivity when doped with impurities such as sulfuric acid, iodine, iron (II) chloride, etc. It is also known that, in the state in which the electrical*

conductivity is increased as described above, absorbance in a visible wavelength region is also increased and optical transmittance is greatly reduced to lose transparency. Therefore, the doping is not preferably carried out when a light emitted is to be taken out from the conducting polymer side of the EL device. Since the absorption spectrum correlates with the electrical conductivity, the electrical conductivity is preferably 0.1 S/cm or less" (column 7, lines 23 to 36).

Accordingly, it would be obvious to the skilled person to consider conductivities well below the upper limit value of 0.1 S/cm in D3 in order to ensure sufficient transparency of the conductive polymer layer as required, thereby arriving at sheet resistance values for the conductive polymer layer falling within the claimed range.

The subject-matter of claim 1 according to the sixth auxiliary request, therefore, also lacks an inventive step in the sense of Article 56 EPC 1973.

Accordingly, the appellant's sixth auxiliary request is not allowable either.

Order

For these reasons it is decided that:

The appeal is dismissed.

Registrar: Chair:

S. Sánchez Chiquero G. Eliasson