Title: OPTO-ELECTRICAL DEVICES WITH ELECTRODE INCORPORATING METAL NANOWIRES

Abstract: The present disclosure relates to OLED and PV devices including transparent electrodes that are formed of conductive nanostructures and methods of improving light out-coupling in OLED and input-coupling in PV devices.
(88) Date of publication of the international search report:
4 May 2013
INTERNATIONAL SEARCH REPORT

PCT/US2012/060101

A. CLASSIFICATION OF SUBJECT MATTER
INV. H01L51/52 H01L51/44 H01B1/22 H01L31/0224
ADD.

According to International Patent Classification (IPC) and to both national classification and IPC

B. FIELDS SEARCHED
Minimum documentation searched (classification system followed by classification symbols)
H01L H01B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
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Further documents are listed in the continuation of Box C. See patent family annex.

* Special categories of cited documents:
  * "X" document defining the general state of the art which is not considered to be of particular relevance
  * "E" earlier application or patent but published on or after the international filing date
  * "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
  * "O" document referring to an oral disclosure, use, exhibition or other means
  * "P" document published prior to the international filing date but later than the priority date claimed
  * "I" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
  * "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
  * "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
  * "A" document member of the same patent family

Date of the actual completion of the international search
5 April 2013

Date of mailing of the international search report
15/04/2013

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NL - 2280 HV Rijswijk
Tel. (+31-31) 340-2040,
Fax. (+31-31) 340-3016

Boetti cher, Harald
<table>
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## INTERNATIONAL SEARCH REPORT

### Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. □ Claims Nos.: because they relate to subject matter not required to be searched by this Authority, namely:

2. □ Claims Nos.: because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. □ Claims Nos.: because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

### Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. □ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. □ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of additional fees.

3. □ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

   18-22 (completely); 1-7 (partly)

4. □ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.: 

### Remark on Protest

□ The additional search fees were accompanied by the applicant’s protest and, where applicable, the payment of a protest fee.

□ The additional search fees were accompanied by the applicant’s protest but the applicable protest fee was not paid within the time limit specified in the invitation.

□ No protest accompanied the payment of additional search fees.

Form PCT/ISA/21 0 (continuation of first sheet (2)) (April 2005)
This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-7 (partially)

Optical stack comprising a substrate, a layer having a refractive index, an electrode of a nanostructure layer with metal nanostructures, an organic stack, another electrode

1.1. claims: 5-7 (partially)

In this optical stack, the layer having the refractive index is optional (a claimed energy density defined by a non-claimed structure without a nanostructure layer is ignored)

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2. claims: 8, 9

A top emitting OLED with a nanostructure layer electrode on an organic stack

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3. claims: 10, 11

Forming on a stack comprising a substrate, a cathode and an organic stack a nanostructure layer by a transfer film carrying the nanostructure layer

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4. claims: 12, 13

Forming a nanostructure layer by forming nanostructures on a release liner and forming a matrix on the nanostructures; transferring this layer by a transfer film from the release liner onto an optical stack

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5. claims: 14-17

Forming a matrix on a release liner, depositing nanostructures on the matrix, relaying the matrix, pressing the nanostructures into the relaided matrix by "the transfer film" (this film is not defined before, so claim 14 seems to lack features required for a meaningful search)

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6. claims: 18-20

OLED with a metal film on an organic film and nanostructures disposed on the interface between these films

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7. claims: 21, 22

OLED with a metal film on an organic stack and
nanostructures on top of the metal film (i.e. not at the interface with the organic stack)

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8. claims: 23-30

OLED with substrate, antireflective layer thereon, electrode thereon, organic stack thereon, electrode thereon, organic stack has organic light emitting material, charge injection layer, hole injection layer

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9. claims: 31-34

Photovoltaic cell with light scattering particles on substrate surface and electrode formed on the particles and having conductive nanostructures

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10. claims: 35-41

OLED with organic stack between a lower and an upper electrode and with substrate through which light generated can exit, a layer between the lower electrode and the substrate having a refractive index being the same or higher than that of the organic stack

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<td>10-08-2005</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CN 102024913 A</td>
<td>20-04-2011</td>
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<tr>
<td></td>
<td></td>
<td>JP 4226835 B2</td>
<td>18-02-2009</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP 2003297572 A</td>
<td>17-10-2003</td>
</tr>
<tr>
<td></td>
<td></td>
<td>KR 20040094861 A</td>
<td>10-11-2004</td>
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<tr>
<td></td>
<td></td>
<td>US 2005127832 A1</td>
<td>16-06-2005</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WO 03084291 A</td>
<td>09-10-2003</td>
</tr>
<tr>
<td>US 2010295446 A1</td>
<td>25-11-2010</td>
<td>CN 101926218 A</td>
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<tr>
<td></td>
<td></td>
<td>EP 2249619 A</td>
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<tr>
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<td></td>
<td>JP 2009181856 A</td>
<td>13-08-2009</td>
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<td>KR 20100137432 A</td>
<td>30-12-2010</td>
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<td>TW 200941508 A</td>
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<td>US 2010295446 A1</td>
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<td></td>
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<td>06-08-2009</td>
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