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- (81) **Designated States (unless otherwise indicated, for every kind of national protection available):** AE, AG, AL, AM,

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- Published:**
  - with international search report (Art. 21(3))
  - before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))
- (88) **Date of publication of the international search report:**  
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(54) **Title:** LIGHTING DEVICES HAVING REMOTE LUMIPHORS THAT ARE EXCITED BY LUMIPHOR-CONVERTED SEMICONDUCTOR EXCITATION SOURCES

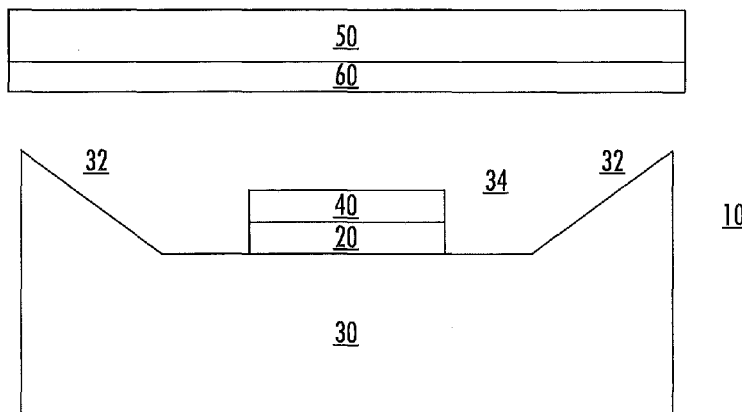


FIG. 2A

(57) **Abstract:** Lighting devices include a semiconductor light emitting device (20) and first and second spaced-apart lumiphors (40, 60). The first lumiphor (40) has a first surface that is positioned to receive radiation emitted by the semiconductor light emitting device and a second surface opposite the first surface. The second lumiphor (60) has a first surface that is positioned to receive radiation emitted by the semiconductor light emitting device and radiation emitted by the luminescent materials in the first lumiphor. The first lumiphor is a leaky lumiphor in that the luminescent materials therein wavelength convert less than 90% of the radiation from the semiconductor light emitting device light that is incident on the first lumiphor.



# INTERNATIONAL SEARCH REPORT

International application No <b>PCT/US2012/036761</b>
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<b>A. CLASSIFICATION OF SUBJECT MATTER</b> INV. H01L33/50 H01L25/075 ADD.		
According to International Patent Classification (IPC) or to both national classification and IPC		
<b>B. FIELDS SEARCHED</b>		
Minimum documentation searched (classification system followed by classification symbols) H01L		
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, COMPENDEX, INSPEC		
<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2007 035885 A (KYOCERA CORP) 8 February 2007 (2007-02-08)	1,2,5,7
Y	abstract; figures 5-8 paragraphs [0004], [0040], [0054] - [0057], [0067]	4,6,8, 10,12,13
X	----- US 2009/195730 A1 (PARK JAE BYUNG [KR] ET AL) 6 August 2009 (2009-08-06)	1-3,5,6
Y	paragraphs [0027] - [0043]; figure 3	10,12,13
X	----- JP 2008 071806 A (KASEI CO C I) 27 March 2008 (2008-03-27)	1-3,7
Y	abstract; figures 1,5,7,8 paragraphs [0010], [0037] - [0038]	4,6,8, 10,12,13
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<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C. <span style="margin-left: 100px;"><input checked="" type="checkbox"/> See patent family annex.</span>		
* Special categories of cited documents :		
"A" document defining the general state of the art which is not considered to be of particular relevance	"T" 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	
"E" earlier application or patent but published on or after the international filing date	"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	
"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)	"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	
"O" document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family	
"P" document published prior to the international filing date but later than the priority date claimed		
Date of the actual completion of the international search	Date of mailing of the international search report	
14 February 2013	21/06/2013	
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer  Marani, Roberta	

## INTERNATIONAL SEARCH REPORT

International application No

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2009 267039 A (CITIZEN ELECTRONICS) 12 November 2009 (2009-11-12)	1-3,5,7, 14
Y	abstract; figures 3-5 paragraphs [0019], [0037] -----	4,6,8
Y	US 2004/007961 A1 (SRIVASTAVA ALOK MANI [US] ET AL) 15 January 2004 (2004-01-15) abstract paragraph [0052]; table I -----	4
Y	US 2007/012928 A1 (PENG ZOUYAN [US] ET AL) 18 January 2007 (2007-01-18) abstract paragraph [0033] -----	4
Y	US 2006/066210 A1 (NG KEE Y [MY] ET AL NG KEE YEAN [MY] ET AL) 30 March 2006 (2006-03-30) paragraphs [0012], [0018], [0024]; figure 3 -----	6
Y	WO 2010/106504 A1 (KONINKL PHILIPS ELECTRONICS NV [NL]; HOELEN CHRISTOPH G A [NL]; VALSTE) 23 September 2010 (2010-09-23) abstract; figures 3a,3c pages 10,18 -----	8
Y	US 2006/028122 A1 (WANG NING [US] ET AL) 9 February 2006 (2006-02-09) paragraphs [0128] - [0130] -----	10,12,13
A	US 2005/117334 A1 (LEE KUN-CHUI [TW] ET AL) 2 June 2005 (2005-06-02) paragraph [0033]; figures 1,4 -----	11

# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US2012/036761

## 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 fees, 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.:
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.:

1-14

### 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.

**FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210**

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-14

Lighting device with two lumiphors, wherein the lumiphor closest to the light emitting element converts less than 90% of the incident radiation.

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2. claims: 15-20

Lighting device comprising a semiconductor light emitting element and two lumiphors, wherein the lumiphors and the light emitting element emit lights of given wavelengths.

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3. claims: 21-25

Lighting device with a plurality of light emitting devices with associated two lumiphors, wherein ratio of the particle size of the luminescent materials of the two lumiphors is at least 1:4.

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4. claims: 26-29

Lighting device comprising a semiconductor light emitting device and two lumiphors, wherein the surface area of the lower surface of the outer lumiphor is at least 10 times larger than the surface of the semiconductor light emitting device.

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# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2012/036761

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 2007035885 A	08-02-2007	JP 5196711 B2 JP 2007035885 A	15-05-2013 08-02-2007
US 2009195730 A1	06-08-2009	CN 101498425 A JP 2009181955 A KR 20090084167 A US 2009195730 A1	05-08-2009 13-08-2009 05-08-2009 06-08-2009
JP 2008071806 A	27-03-2008	NONE	
JP 2009267039 A	12-11-2009	JP 5133120 B2 JP 2009267039 A	30-01-2013 12-11-2009
US 2004007961 A1	15-01-2004	AU 6460701 A CN 1636259 A EP 1332520 A1 JP 2004501512 A US 6621211 B1 US 2004007961 A1 WO 0189001 A2	26-11-2001 06-07-2005 06-08-2003 15-01-2004 16-09-2003 15-01-2004 22-11-2001
US 2007012928 A1	18-01-2007	US 2007012928 A1 WO 2007009010 A2	18-01-2007 18-01-2007
US 2006066210 A1	30-03-2006	CN 1755958 A JP 2006108661 A US 2006066210 A1	05-04-2006 20-04-2006 30-03-2006
WO 2010106504 A1	23-09-2010	CA 2755838 A1 CN 102356479 A EP 2412038 A1 JP 2012521086 A KR 20110129968 A US 2012007130 A1 WO 2010106504 A1	23-09-2010 15-02-2012 01-02-2012 10-09-2012 02-12-2011 12-01-2012 23-09-2010
US 2006028122 A1	09-02-2006	AU 2004322659 A1 BR PI0418982 A CA 2575841 A1 EP 1778816 A2 KR 20060080645 A KR 20060093259 A KR 20060093260 A TW I374926 B US 2006028122 A1 WO 2006022792 A2	02-03-2006 11-12-2007 02-03-2006 02-05-2007 10-07-2006 24-08-2006 24-08-2006 21-10-2012 09-02-2006 02-03-2006
US 2005117334 A1	02-06-2005	DE 102004023110 A1 JP 3128699 U JP 2005167177 A KR 20050051533 A TW I263356 B US 2005117334 A1	30-06-2005 25-01-2007 23-06-2005 01-06-2005 01-10-2006 02-06-2005