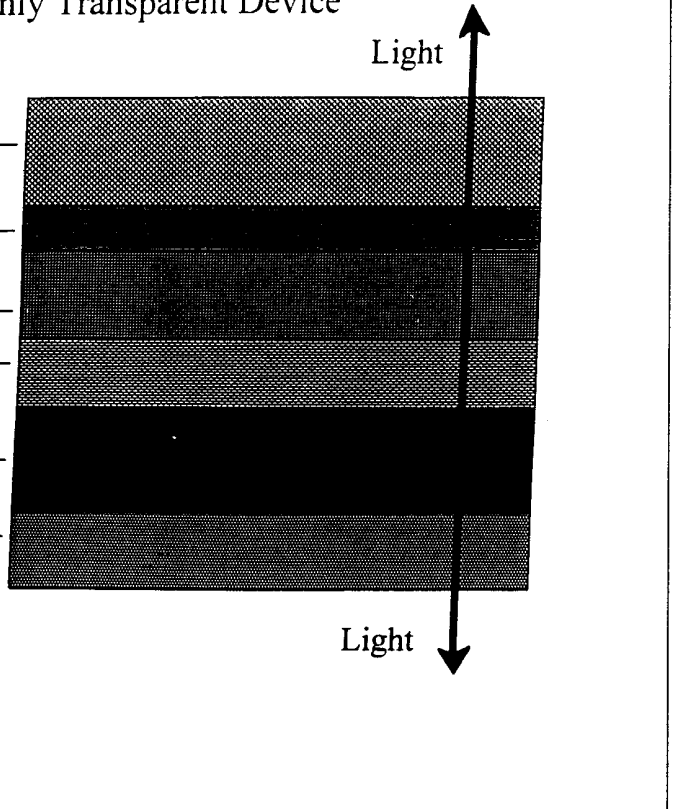




## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification <sup>6</sup> : <b>H05B 33/28</b>	<b>A3</b>	(11) International Publication Number: <b>WO 99/20081</b>																							
		(43) International Publication Date: 22 April 1999 (22.04.99)																							
<p>(21) International Application Number: PCT/US98/21171</p> <p>(22) International Filing Date: 8 October 1998 (08.10.98)</p> <p>(30) Priority Data:</p> <table border="0"> <tr><td>08/948,130</td><td>9 October 1997 (09.10.97)</td><td>US</td></tr> <tr><td>60/064,005</td><td>3 November 1997 (03.11.97)</td><td>US</td></tr> <tr><td>08/964,863</td><td>5 November 1997 (05.11.97)</td><td>US</td></tr> <tr><td>08/980,986</td><td>1 December 1997 (01.12.97)</td><td>US</td></tr> <tr><td>09/053,030</td><td>1 April 1998 (01.04.98)</td><td>US</td></tr> <tr><td>09/053,707</td><td>3 April 1998 (03.04.98)</td><td>US</td></tr> <tr><td>09/058,305</td><td>10 April 1998 (10.04.98)</td><td>US</td></tr> <tr><td>09/152,960</td><td>14 September 1998 (14.09.98)</td><td>US</td></tr> </table> <p>(71) Applicants: THE TRUSTEES OF PRINCETON UNIVERSITY [US/US]; Box 36, Princeton, NJ 08544 (US). THE UNIVERSITY OF SOUTHERN CALIFORNIA [US/US]; The University of Southern California Park, Los Angeles, CA 90089 (US).</p> <p>(72) Inventors: FORREST, Stephen, R.; 148 Hunt Drive, Princeton, NJ 08540 (US). BURROWS, Paul; 413 Clarksville Road, Princeton Junction, NJ 08550 (US). PARTHASARATHY, Gautam; J303 E-Quad, Olden Street, Princeton, NJ 08540 (US). O'BRIEN, Diarmuid; 199 Griffith Avenue, Drumcondra, Dublin 9 (IE). THOMPSON, Mark, E.; 4447 Pep-</p>	08/948,130	9 October 1997 (09.10.97)	US	60/064,005	3 November 1997 (03.11.97)	US	08/964,863	5 November 1997 (05.11.97)	US	08/980,986	1 December 1997 (01.12.97)	US	09/053,030	1 April 1998 (01.04.98)	US	09/053,707	3 April 1998 (03.04.98)	US	09/058,305	10 April 1998 (10.04.98)	US	09/152,960	14 September 1998 (14.09.98)	US	<p>per Creek Way, Anaheim, CA 92807 (US). YU, Yujian; Building 10, Apartment C-7, 700 Lower State Road, North Wales, PA 19454 (US). SHOUSTIKOV, Andrei; 1175 W. 29th Street No.8, Los Angeles, CA 90007 (US). PETASIS, Nicos, A.; 16234 Sierra Pass, Hacienda Heights, CA 91745 (US). SIBLEY, Scott; Apartment 2D, No. 1 Duncroft Court, Baltimore, MD 21236 (US). LOY, Douglas.; 12750 Centralia Street #2, Lakewood, CA 90715 (US). KOENE, Brian, E.; 26 Beacon Street, Burlington, MA 01803 (US). KWONG, Raymond, C.; 943 W. Carson Street #308, Torrance, CA 90502 (US).</p> <p>(74) Agents: MEAGHER, Thomas, F. et al.; Kenyon &amp; Kenyon, One Broadway, New York, NY 10004 (US).</p> <p>(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, GM, HR, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).</p> <p><b>Published</b> <i>With international search report.</i> <i>Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i></p> <p>(88) Date of publication of the international search report: 26 August 1999 (26.08.99)</p>
08/948,130	9 October 1997 (09.10.97)	US																							
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09/058,305	10 April 1998 (10.04.98)	US																							
09/152,960	14 September 1998 (14.09.98)	US																							
(54) Title: HIGHLY TRANSPARENT NON-METALLIC CATHODES																									
(57) Abstract																									
<p>A novel class of low reflectivity, high transparency, non-metallic cathodes (1) useful for a wide range of electrically active, transparent organic devices is disclosed. As a representative embodiment, the highly transparent non-metallic cathode (1) of an OLED employs a thin film of copper phthalocyanine (CuPc) (6) capped with a film of low-power, radio-frequency sputtered indium-tin-oxide (ITO). The CuPc prevents damage to the underlying organic layers during the ITO sputtering process. Due to the low reflectivity of the non-metallic cathode, a non-antireflection-coated, non-metallic-cathode-containing TOLED is disclosed that is 85 % transmissive in the visible, emitting nearly identical amounts of light in the forward and back-scattered directions.</p>	<p style="text-align: center;">Highly Transparent Device</p>  <p>The diagram illustrates a cross-section of a highly transparent device. It consists of six distinct layers, labeled 1 through 6 from top to bottom. Layer 1 is the topmost layer, followed by layer 6, then layer 2, layer 3, layer 4, and layer 5 as the bottommost layer. A vertical arrow labeled 'Light' points downwards from the top of layer 1, passing through all six layers, and exiting from the bottom of layer 5. This indicates that light is transmitted through the device in both forward and back-scattered directions.</p>																								

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DK	Denmark	LR	Liberia	SG	Singapore		
EE	Estonia						

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US98/21171**A. CLASSIFICATION OF SUBJECT MATTER**IPC(6) :H05B 33/28  
US CL :313/503

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

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 313/503; 428/690, 917; 427/66

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)

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5,457,565 A [NAMIKI et al.] 10 October 1995, col. 4, line 12.	1-7
X	WHITLOCK et al. Investigations of Materials and Device Structures for Organic Semiconductor Solar Cells, Optical Eng., Vol. 32, No. 8, 1921-1934 (August 1993), especially page 1921.	1-7, 11-24
X	BULOVIC et al. Transparent Light-emitting Devices, Nature 380, 29 (1996).	1-7

 Further documents are listed in the continuation of Box C.
  See patent family annex.

* Special categories of cited documents:	*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
*A* document defining the general state of the art which is not considered to be of particular relevance	*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
*E* earlier document published on or after the international filing date	*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
*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)	*G* document member of the same patent family
*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	

Date of the actual completion of the international search

25 MARCH 1999

Date of mailing of the international search report

07 JUL 1999

Name and mailing address of the ISA/US  
Commissioner of Patents and Trademarks  
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## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US98/21171**Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)**

This international 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.: 8-10, 25-52, 58-107  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

**Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)**

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

Please See Extra 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 any additional fee.
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.:  
1-7 and 11-24

Remark on Protest  The additional search fees were accompanied by the applicant's protest.  
 No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US98/21171

**BOX II. OBSERVATIONS WHERE UNITY OF INVENTION WAS LACKING**

This ISA found multiple inventions as follows:

This application contains the following inventions or groups of inventions which are not so linked as to form a single inventive concept under PCT Rule 13.1. In order for all inventions to be searched, the appropriate additional search fees must be paid.

Group I, claim(s)1-7 and 11-24, drawn to a cathode.

Group II, claim(s)53-57, drawn to a composition.

The inventions listed as Groups I and II do not relate to a single inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons: The Group I claims share the same technical feature in that they are related to a non-metallic cathode and the Group II claims relate to a luminescent composition.