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[Continued on next page]

(54) Title: Organic-Inorganic Complexes Containing a Luminescent Rare earth-Metal Nanocluster and an Antenna Ligand, Luminescent Articles, and Methods of Making Luminescent Compositions

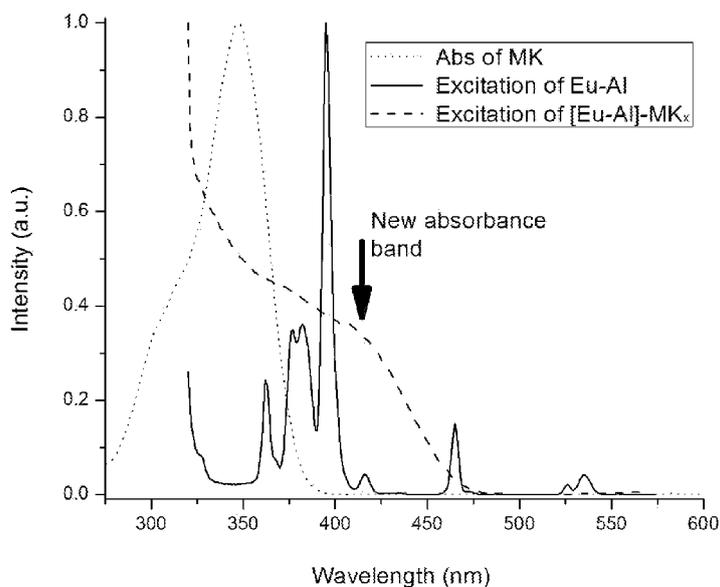


Fig. 7

(57) Abstract: Luminescent compositions are described comprising lanthanide-containing nanoclusters comprising lanthanide atoms bonded to at least one semimetal or transition metal via an oxygen or sulfur atom. Novel compositions include an antenna ligand complexed with the nanoclusters. The rare earth-metal nanoclusters are in the size range of 1 to 100 nm. Articles, such as solar cells, are described in which the nanoclusters (with or without antenna ligands) are dispersed in a polymer matrix. Novel methods of making luminescent films are also described.



SE, SG, SK, SL, SM, ST, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

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**Published:**

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- 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))

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## INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER INV. C09K11/06 C07F5/06 H01L31/055		
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) C09K C07F 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 practical, search terms used) EPO-Internal		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 2006/004187 A1 (KRI INC [JP]; MATAKI HIROSHI [JP]; FUKUI TOSHIMI [JP]) 12 January 2006 (2006-01-12) page 12, line 10 - page 14, line 30; figure 1 page 27, line 7 - line 28 example 3	1,3-12, 15
Y	WERTS M H V, DUIN M A, HOFSTRAAT J W, VERHOEVEN J W: "Bathochromicity of Michlers ketone upon coordination with lanthanide(III) beta-diketonates enables efficient sensitisation of Eu3+ for luminescence under visible light excitation" CHEM COMMUN, 1999, pages 799-800, XP002552270 the whole document	1,3-12, 15
-/-		
<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> See patent family annex.		
* 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	
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"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  26 October 2009	Date of mailing of the international search report  22/02/2010	
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## INTERNATIONAL SEARCH REPORT

International application No  
PCT/US2009/054371

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	<p>TANG ET AL: "Effect of ligand-antenna integration (ALI) in macromolecular structures on fluorescent property of processable macromolecule-lanthanide complexes" OPTICAL MATERIALS, ELSEVIER SCIENCE PUBLISHERS B.V. AMSTERDAM, NL, vol. 29, no. 12, 23 June 2007 (2007-06-23), pages 1774-1781, XP022126854 ISSN: 0925-3467 the whole document</p>	1,3-12, 15
Y	<p>WO 02/087283 A1 (ELAM T LTD [GB]; KATHIRGAMANATHAN POOPATHY [GB]; RAVICHANDRAN SEENIVAS) 31 October 2002 (2002-10-31) examples 1, 2</p>	1

# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US2009/054371

## 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, 15(completely); 3-14, 19(partially)

### 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, 15(completely); 3-14, 19(partially)

Composition comprising:

- a polymer matrix
  - rare earth metal nanoclusters with lanthanide atoms bonded to semimetal or transition metal via oxygen or sulfur atom
  - antenna ligands
- device comprising the same and methods of making said composition

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2. claims: 2(completely); 3-14, 19(partially)

Composition comprising:

- rare earth metal nanoclusters with lanthanide atoms bonded to semimetal or transition metal via oxygen or sulfur atom
  - antenna ligands
- device comprising the same and methods of making said composition

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3. claims: 16-18

Composition comprising:

- rare earth metal nanoclusters with lanthanide atoms bonded to semimetal or transition metal via oxygen atom
  - cyclic olefin bonded to rare earth nanocluster
- device comprising the same and methods of making said composition

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4. claims: 20-30

Solar cell with coating comprising:

- organic host
- luminescent rare-earth nanocluster wherein the rare earth is coordinated to a metal via oxygen or sulfur atom

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# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2009/054371

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2006004187 A1	12-01-2006	US 2008287583 A1	20-11-2008
WO 02087283 A1	31-10-2002	US 2004137264 A1	15-07-2004