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[Continued on next page]

(54) Title: METAL COATING OF RARE EARTH NANO-PHOSPHORS AND USES THEREOF

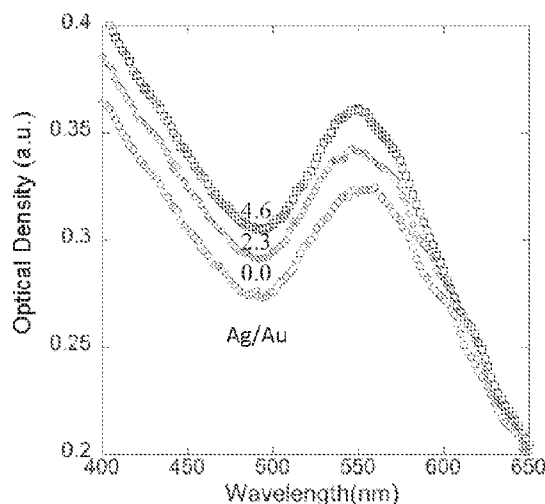


FIG. 20

(57) Abstract: Core-shell nanoparticles comprises a phosphorescent core and metal shell comprising at least two metals. The phosphorescent core may comprise an up converting phosphor. The phosphorescent core may comprise a trivalent rare earth cation. The phosphorescent core further may comprise a monovalent alkali metal. The phosphorescent core may optionally comprises a second and also optionally a third trivalent rare earth cation.



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- *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))*

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 11/65411

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - C04B 12/04 (2012.01)

USPC - 106/624; 106/802

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)

IPC(8)- C04B 12/04 (2012.01);

USPC- 106/624; 106/802

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Patents and NPL (classification, keyword; search terms below)Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
PubWest (US Pat, PgPub, EPO, JPO), GoogleScholar (PL, NPL), FreePatentsOnline (US Pat, PgPub, EPO, JPO, WIPO, NPL);
search terms: nanoparticle, nm, nano, nanometer, particle, phosphoresce, phosphor, fluresce, core, metal metallic, shell, earth, metal, cation, ion, sodium, Na

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2010/0261263 A1 (VO-DINH et al.) 14 October 2010 (14.10.2010), para [0070], [0074], [0095], [0097], [0115], [0125], [0148], [0234]	1-4, 14
X, P	WO 2011/084641 A2 (KENNEDY et al.) 14 July 2011 (14.07.2011), para [0007]-[0060]	1-4, 14
Y	US 2009/0227044 A1 (DOSEV et al.) 10 September 2009 (10.09.2009), para [0015]-[0110]	1-4, 14
Y	US 2009/0022766 A1 (GEDDES) 22 January 2009 (22.01.2009), para [0073], [0086]	1-4, 14
Y	US 2007/0212542 A1 (GUO et al.) 13 September 2007 (13.09.2007), para [0013]-[0053]	1-4, 14
Y	US 2007/0212541 A1 (TSUKADA et al.) 13 September 2007 (13.09.2007), para [0021]-[0102]	1-4, 14

☐ Further documents are listed in the continuation of Box C.

* Special categories of cited documents:

"A" 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

"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

"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

"&" document member of the same patent family

Date of the actual completion of the international search

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 11/65411

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.: 5-13, 15-22
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:
This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fees must be paid.

Group I: claims 1-4, 14 directed to a nanoparticle comprising a phosphorescent core and a metal shell wherein said metal shell comprises a first and a second metal.

Group II: claims 23-24 directed to a security paper comprising a plurality of nanoparticles wherein said nanoparticles are visible and of a first color and upon excitation with a low-powered laser, said nanoparticles emit a second color.

-- 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 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.:
1-4, 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.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 11/65411

Continued from Box No. III, Observations where unity of invention is lacking:

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

Group I: claims 1-4, 14 directed to a nanoparticle comprising a phosphorescent core and a metal shell wherein said metal shell comprises a first and a second metal.

Group II: claims 23-24 directed to a security paper comprising a plurality of nanoparticles wherein said nanoparticles are visible and of a first color and upon excitation with a low-powered laser, said nanoparticles emit a second color.

The inventions listed as Groups I-II do not relate to a single general inventive concept under PCT Rule 13.1 because under PCT Rule 13.2 they lack the same or corresponding technical features for the following reasons:

Group I does not include the security paper comprising a plurality of nanoparticles wherein said nanoparticles are visible and of a first color and upon excitation with a low-powered laser, said nanoparticles emit a second color of group II.

Group II does not include the nanoparticle comprising a phosphorescent core and a metal shell of group I.

The common feature of a nanoparticle with a phosphorescent property of groups I and II is taught by US 2009/0022766 A1 to Geddes (para [0073]; [0086]); therefore the common feature is not an improvement over the prior art.

None of these technical features are common to the other groups, nor do they correspond to a special technical feature in the other groups. Therefore, unity of invention is lacking.