SYNTHESIS OF HIGHLY FLUORESCING SEMICONDUCTING CORE-SHELL NANOPARTICLES BASED ON IB, IIB, IIIA, VIA ELEMENTS OF THE PERIODIC CLASSIFICATION.

A method for the preparation of semiconducting core-shell nanoparticles comprising elements of the groups IB, IIB, II, VIA, VA or VIA of the periodic classification wherein the composition of the core nanoparticle is selected from the group consisting of IB-VIA, IIB-VIA, IIIA-VIA, IB-IIA-VIA or IB-IIA-IVA-VIA, IIB-IIA-VIA or IIB-IVA-VA or mixtures thereof, and at least one shell comprises elements of the groups IB and VIA, wherein in case the core composition is IIB-VIA the shell comprises at least a further element selected from the groups IB, IIIA, rVA or VA, said method comprising the following steps: i.)Core reaction mixture comprising at least one cation metal precursors and an anion precursor is dissolved in a liquid and solvent mixture at a temperature that is still beneath the threshold at which nucleation takes place, j.)Core reaction mixture is heated above nucleation threshold temperature and then kept at the reaction temperature for core nucleation, k.)Optionally the heated reaction mixture is kept at a temperature well suited for core growth but lower than the nucleation temperature, l.)Shell reaction mixture prepared separately comprising at least one cation metal precursors and an anion precursor and heated at a temperature that is still beneath the threshold at which nucleation takes place is added to the reaction mixture of step b) or c) for shell coating of the core nanoparticles, m.)reaction mixture of step d) is heated and hold to a shell growth temperature, n.)optionally for ZnS shell preparation shell reaction mixture comprising ZnS shell material is prepared separately and heated at a temperature that is still beneath the threshold at which nucleation takes place is added to the reaction mixture of step d) or e) for shell coating of the nanoparticles, o.)reaction mixture of step f) is heated and hold to a shell growth temperature, p.)reaction mixture is then cooled down to prevent further particle growth.
**INTERNATIONAL SEARCH REPORT**

**A. CLASSIFICATION OF SUBJECT MATTER**

INV. C09K11/56 C09K11/62

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

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, COMPENDEX, INSPEC, WPI Data

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

<table>
<thead>
<tr>
<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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</table>

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

*X* 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(s) which may throw doubts on priority claim(s) or which are cited to establish thepublication 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

**Date of the actual completion of the international search**

17 January 2013

**Date of mailing of the international search report**

06/02/2013

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

Dosli k, Natasa

Form PCT/ISA/210 (second sheet) (April 2005)
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<td>X</td>
<td>LIANG LI ET AL: “Highly Luminous CuInS2/ZnS Core/Shell Nanocrystal Quantum Dots for In Vivo Imaging”, CHEMISTRY OF MATERIALS, vol. 21, no. 12, 23 June 2009 (2009-06-23), pages 2422-2429, DOI: 10.1021/cm900103b, page 2422 - page 2428; figures 1-10, 4-10, 14-16</td>
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<td>X</td>
<td>JAEHYUN PARK ET AL: “CuInS2/ZnS Core/Shell Quantum Dots by Cation Exchange and their Blue-Shifted Photoluminescence”, JOURNAL OF MATERIALS CHEMISTRY, vol. 21, no. 11, 1 January 2011 (2011-01-01), page 3745, DOI: 10.1039/c0jm03194a, page 3745 - page 3749; figures 1-10, 14-16</td>
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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 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.:

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

1. Claims: 1-10 (completely) 14-16 (partially)

   The first group of inventions relates to a method for preparing semiconductor core-shell nanoparticles and the core-shell nanoparticles per se comprising elements of the groups IB, IIB, IVA, or VIA of the periodic classification, wherein the composition of the core nanoparticles is selected from the group consisting of IB-VIA, IIB-VIA, IIB-IVA, IB-IIB-IIB-IVA, IB-IIB-IVA-VIA, IIB-IIB-IVA-VIA, IIB-IVA-VIA or mixtures thereof and at least one shell comprises an element of groups IIB and VIA.

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2. Claims: 11-13 (completely) 14-16 (partially)

   The second group of inventions relates to semiconductor core-shell nanoparticles with the general formula as defined by claim 11.

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<td>WO 2009094160 A2</td>
<td>30-07-2009</td>
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