(57) Abstract: The FAD-dependent enzyme glutathione reductase catalyzes the NADPH-dependent synthesis of gold, platinum, and mixed-metal nanoparticles, which are strongly bound to the active site via the redox active cysteine residues. The enzyme stabilizes very small (~5 atom) metallic clusters, and prevents larger clusters from aggregating in the absence of capping ligands. Juxtaposition of the nanoparticle with the FAD cofactor via the active site cysteines enables the maintenance of the nanoparticle at a low potential in the presence of excess NADPH. This allows layered deposition of metals irrespective of redox potential, and the stabilization of low potential metals toward oxidation in aqueous solution. Solid-phase glutathione reductase catalyzed synthesis of gold nanoparticles is demonstrated and proposed as a means to large-scale production of a variety of unique nanoparticle structures.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
IPC: C12P 3/00 (2007.01); B82B 3/00 (2007.01)

USPC: 435/168; 977/842
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.: 435/168; 977/842

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)
Please See Continuation Sheet

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>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>US 6,562,823 B2 (EMPEDOCLES et al) 08 November 2003 (08.11.2003), abstract, background and summary of the invention, claims.</td>
<td>1-20</td>
</tr>
</tbody>
</table>

[X] Further documents are listed in the continuation of Box C.

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
  "E" earlier application or patent 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
  "R" laser 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
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  "&" document member of the same patent family

Date of the actual completion of the international search
23 October 2006 (22.10.2006)

Name and mailing address of the ISA/US
Mail Stop PCT, Attn: ISA/US Commissioner for Patents
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Alexandria, Virginia 22313-1450
Facsimile No. (571) 273-3201

Authorized officer
Sathyendra K. Singh
Telephone No. 571-272-8790

Date of mailing of the international search report
28 Nov 2000

Form PCT/ISA/210 (second sheet) (April 2005)
<table>
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<tbody>
<tr>
<td>A</td>
<td>SHANKAR S.S. et al. Rapid synthesis of Au, Ag, and bimetallic Au core-Ag shell nanoparticles using Neem (Azadirachta indica) leaf broth, J. Colloid Interface Sci. 2004, Vol. 275, No. 2, pages 496-502, especially page 496.</td>
<td>1-20</td>
</tr>
</tbody>
</table>
Continuation of B. FIELDS SEACHED Item 3:
EAT:
USPAT, USOCR, US-PGPUB, IPO, EPO, DERWENT
STN:
CAPLUS, BIOSIS, MEDLINE
SEARCH STRATEGIES:
nanopart? or nanogold or nanostr? or nanotub? or nanowir? or (carbon nanotub?)
enzym? or reduct? or (glutathion? reduct?) or reductas?
(metal ion?) or (gold or platinum or silver or nickel or iron or cobalt); and (enzym? reduct?)