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(74) Agents: VAN DYKE, Timothy, H. et al.; Beusse Wolter Sanks Mora & Maire, 390 N. Orange Avenue, Suite 2500, Orlando, FL 32801 (US).

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(71) Applicant (for all designated States except US): UNIVERSITY OF FLORIDA RESEARCH FOUNDATION, INC. [US/US]; 223 Grinter Hall, Gainesville, FL 32611 (US).

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(72) Inventors; and

(75) Inventors/Applicants (for US only): FLORES, Glen, P. [US/US]; 907 SW 79th Terrace, Gainesville, Florida 32607 (US). BATICH, Christopher, D. [US/US]; 3733 N.W. 40th Street, Gainesville, Florida 32606 (US).

[Continued on next page]

(54) Title: BIOCOMPATIBLE CONDUCTIVE INKS

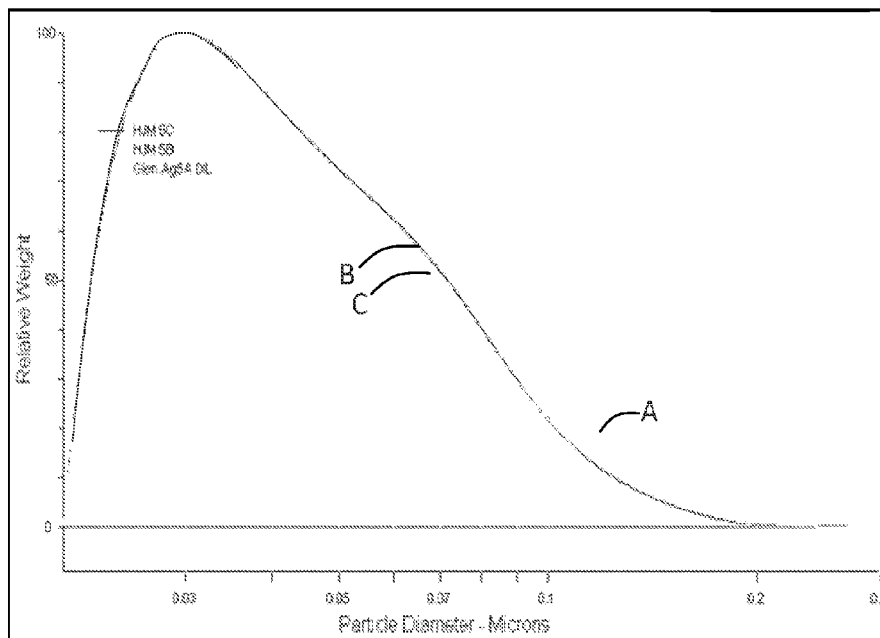


FIG. 1

(57) Abstract: This invention relates to compositions and methods related to biocompatible conductive inks. In a preferred embodiment the inks are printable onto biocompatible substrates and are used in the creation of biocompatible medical devices, in general, the inks comprise a plurality of particles. In one embodiment, the particles have a particle surface and an agent on the particle surface, the agent configured to prevent the particles from agglomerating when the particles are in a solution, the agent also configured to allow adjacent particle surfaces to be in contact when the particles are not in the solution due to an opening in the agent.



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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))*

**A. CLASSIFICATION OF SUBJECT MATTER***C09D 11/00(2006.01)i, H01B 1/22(2006.01)i*

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)

C09D 11/00; B05D 5/12; C08K 11/00; C09D 11/02; H01B 1/22; H01L 23/48; H01L 21/00; H01B 5/14

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPO internal) &amp; Keywords: nanoparticle, silver nanoparticle, conductive, conductor, agglomeration, dispersant, PVP, biocompatible, terpineol, cellulose, PET, PMMA, ink, surfactant

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2005-0238804 A1 (ARKADY GARBAR et al.) 27 October 2005 See [0019]-[0032] and [0074]	1-17
A	US 2005-0136638 A1 (JESSICA VOSS-KEHL et al.) 23 June 2005 See [0008]-[0022]	1-17
A	US 2008-0078302 A1 (JONG TAIK LEE et al.) 03 April 2008 See [0034]-[0035] and [0062]-[0064]	1-17
A	US 2008-0113195 A1 (BOLL MATTHIAS et al.) 15 May 2008 See [0027]-[0037]	1-17
A	JP 2008-176951 A (MITSUBISHI CHEMICALS CORP) 31 July 2008 See [0023]-[0055]	1-17

 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 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 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

"&amp;" document member of the same patent family

Date of the actual completion of the international search

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Date of mailing of the international search report

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Korean Intellectual Property Office  
Government Complex-Daejeon, 189 Cheongsa-ro,  
Seo-gu, Daejeon 302-701, Republic of Korea

Facsimile No. 82-42-472-7140

Authorized officer

Choi Young Hee

Telephone No. 82-42-481-8156



**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:

Group 1: Claims 1-17 are directed to a composition comprising: a plurality of particles having a particle surface and an agent on the particle surface, the agent configured to prevent the particles from agglomerating when the particles are in a solution, the agent also configured to allow adjacent particle surfaces to be in physical contact when the particles are not in the solution due to an opening in the agent.

Group 2: Claims 18-23 are directed to a composition comprising: a plurality of particles having a particle surface and an agent on the particle surface; and wherein the agent contains a multimodal distribution of chain lengths, the agent is configured to prevent the particles from agglomerating when the particles are in a solution and the agent is configured to control the geometry the particles.

(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.: 1-17

**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**

Information on patent family members

International application No.

**PCT/US2011/025937**

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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JP 2008-176951 A	31.07.2008	None	

(Continuation of Box No.III)

Group 3: Claims 24-44 are directed to a process for producing coatings comprising: forming particles in a solution, the particles having a particle surface and an agent on the particle surface; removing the particles from the solution; and wherein the agent is configured to prevent the particles from agglomerating in the solution, the agent is configured to control the particle geometry and the agent is configured to allow adjacent particle surfaces to be in contact when the particles are not in the solution.

Group 4: Claim 45 is directed to a biocompatible ink comprising: a plurality of non-agglomerated conductive nanoparticles and a unimodal or multimodal mixture of biocompatible protective agent.

Group 5: Claims 46-50 are directed to a process for producing a biocompatible conductive ink comprising: mixing a biocompatible agent and a conductive source in an aqueous solution; recovering the conductive particles from the aqueous solution; and wherein the agent is configured to prevent the particles from agglomerating in the solution and the agent is configured to control the particle geometry.

Group 6: Claim 51 is directed to a biocompatible film comprising: a plurality of non-agglomerated metal nanoparticles, wherein the nanoparticles have an electrical resistivity of  $1\Omega\text{-cm}$  or less and are sintered to form a film; and wherein the biocompatible film is ingestible.

Group 7: Claims 52-56 are directed to a printed biocompatible article comprising: a biocompatible substrate having a biocompatible ink printed thereon in a predetermined pattern; and wherein the biocompatible ink comprises a plurality of conductive particles.

Group 8: Claim 57 is directed to a process for creating inks comprised of sintered particles or particles connected to each other using binding agents that do not release non-biocompatible agents or non-biocompatible that are coated with metal or other agent that can retain non-biocompatible particles.

Group 9: Claim 58 is directed to a composition comprising a conductive ink with a multimodal agent on a surface of the particles that provides for increased conductivity and lower sintering temperatures.

Group 10: Claim 59 is directed to a nanoparticle ink that can be placed onto a substrate and sintered at a temperature that is less than a temperature at which the substrate degrades, has a resistivity of  $1\Omega\text{-cm}$  or less after being sintered or cured or dried and is biocompatible.

Group 11: Claims 60-61 are directed to an electronic device comprising: a conductive trace printed on a biocompatible substrate, the conductive trace containing a plurality of particles, each particle having a conductor, a conductor surface and an agent on the conductor surface, wherein adjacent conductor surfaces are in electrical contact through at least one opening in the agent.

Group 12: Claims 62-67 are directed to an electronic device comprising: a first conductive trace consisting of a plurality of printed nanoparticles of a first species; a second conductive trace consisting of a plurality of printed nanoparticles of a second species; and wherein the two traces produce a galvanic cell capable of producing electrical current and voltage.