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[Continued on next page]

(54) Title: COMPOSITE ZIRCONIA-CALCIUM PHOSPHATE CERAMIC FOR DENTAL IMPLANTS

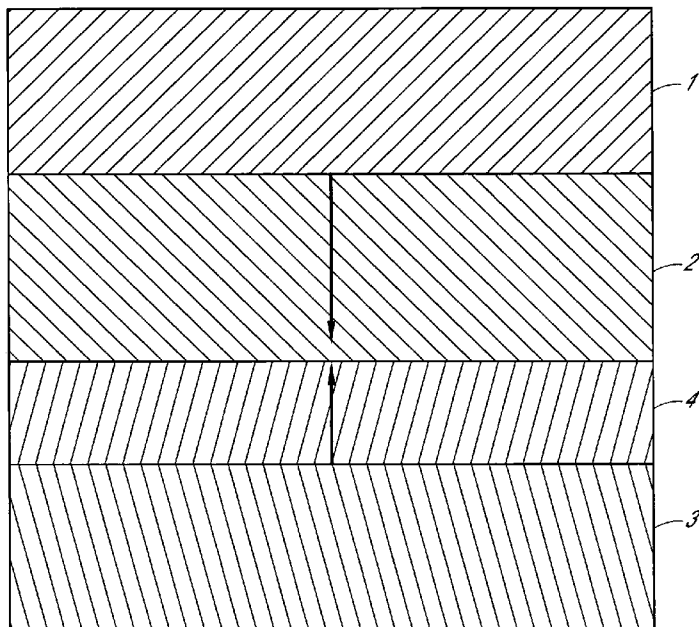


FIG. 1

(57) Abstract: A bioactive ceramic nanocomposite is described as follows. The composite material comprises a ceramic nanocomposite including a plurality of first grains which include calcium phosphate. The average grain size is one micron or less. The calcium phosphate is present in the nanocomposite material in the range of 10% by weight to 70% by weight based on the total weight of the nanocomposite material. A plurality of second grains is rapid sintered to the calcium phosphate-containing grains by using a dynamic sintering technique, such as spark plasma sintering (SPS). The second type of grains may be selected from the group consisting of zirconia and alumina and also have an average grain size of one micron or less. Preferably the zirconia contains 2-10 wt% yttria.

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- *with international search report (Art. 21(3))*
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INTERNATIONAL SEARCH REPORT

International application No
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A. CLASSIFICATION OF SUBJECT MATTER INV. C04B35/117 C04B35/447 C04B35/488 C04B35/645 A61C8/00 A61K6/033 A61K6/02 ADD. 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) C04B A61C A61K 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, WPI Data, COMPENDEX, INSPEC											
C. DOCUMENTS CONSIDERED TO BE RELEVANT <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 10%;">Category*</th> <th style="width: 70%;">Citation of document, with indication, where appropriate, of the relevant passages</th> <th style="width: 20%;">Relevant to claim No.</th> </tr> </thead> <tbody> <tr> <td style="text-align: center; vertical-align: top;">X</td> <td style="vertical-align: top;"> GUO ET AL.: "Laminated and functionally graded hydroxyapatite/yttria stabilized tetragonal zirconia composites fabricated by spark plasma sintering", BIOMATERIALS, vol. 24, 2003, pages 667-675, XP004393192, cited in the application paragraph [0001] part 2, materials and methods; page 669, last paragraph ----- </td> <td style="vertical-align: top; text-align: center;"> 1-3,5,6, 8-15 </td> </tr> <tr> <td style="text-align: center; vertical-align: top;">X</td> <td style="vertical-align: top;"> GAO ET AL.: "Fabrication of HAp-ZrO₂ (3Y) nano-composite by SPS", BIOMATERIALS, vol. 24, 2003, pages 937-940, XP004399586, cited in the application the whole document ----- <div style="text-align: right;">-/-</div> </td> <td style="vertical-align: top; text-align: center;"> 1,2,5-15 </td> </tr> </tbody> </table>			Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.	X	GUO ET AL.: "Laminated and functionally graded hydroxyapatite/yttria stabilized tetragonal zirconia composites fabricated by spark plasma sintering", BIOMATERIALS, vol. 24, 2003, pages 667-675, XP004393192, cited in the application paragraph [0001] part 2, materials and methods; page 669, last paragraph -----	1-3,5,6, 8-15	X	GAO ET AL.: "Fabrication of HAp-ZrO ₂ (3Y) nano-composite by SPS", BIOMATERIALS, vol. 24, 2003, pages 937-940, XP004399586, cited in the application the whole document ----- <div style="text-align: right;">-/-</div>	1,2,5-15
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<div style="display: flex; justify-content: space-between;"> <div> <input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C. </div> <div> <input checked="" type="checkbox"/> See patent family annex. </div> </div>											
<div style="display: flex;"> <div style="flex: 1;"> <p>* Special categories of cited documents :</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier application or patent but published on or after the international filing date</p> <p>"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)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> </div> <div style="flex: 1;"> <p>"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</p> <p>"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</p> <p>"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</p> <p>"&" document member of the same patent family</p> </div> </div>											
Date of the actual completion of the international search <div style="text-align: center; font-size: 1.2em;">8 July 2013</div>		Date of mailing of the international search report <div style="text-align: center; font-size: 1.2em;">16/07/2013</div>									
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 <div style="text-align: center; font-size: 1.2em;">Raming, Tomas</div>									

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2012/002721

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	<p>ERIK ADOLFSSON ET AL: "Phase analysis and thermal stability of hot isostatically pressed zirconia-hydroxyapatite composites", JOURNAL OF THE AMERICAN CERAMIC SOCIETY, BLACKWELL PUBLISHING, MALDEN, MA, US</p> <p>, vol. 83, no. 11 1 November 2000 (2000-11-01), pages 2798-2802, XP008159032, ISSN: 0002-7820, DOI: 10.1111/J.1151-2916.2000.TB01634.X Retrieved from the Internet: URL:http://www3.interscience.wiley.com/cgi-bin/issn?DESCRIPTOR=PRINTISSN&VALUE=0002-7820 [retrieved on 2004-12-20] figure 2</p>	1,2,5-7, 14,15
X	<p>MIAO X ET AL: "Spark plasma sintered hydroxyapatite-yttria stabilized zirconia composites", CERAMICS INTERNATIONAL, ELSEVIER, AMSTERDAM, NL, vol. 30, no. 7, 1 January 2004 (2004-01-01), pages 1793-1796, XP004534341, ISSN: 0272-8842, DOI: 10.1016/J.CERAMINT.2003.12.117 the whole document</p>	1-3,5,6, 8-14
X	<p>SHUFENG LI ET AL: "Fabrication of hydroxyapatite- incorporated ZrO₂-20 wt% Al₂O₃ by spark plasma sintering and characterization", JOURNAL OF COMPOSITE MATERIALS, SAGE PUBLICATIONS, USA, vol. 43, no. 14, 1 July 2009 (2009-07-01), pages 1503-1517, XP008159039, ISSN: 0021-9983 [retrieved on 2009-06-03] page 1506 page 1509 - page 1510 page 1514</p>	1-7, 11-15
X	<p>US 6 013 591 A (YING JACKIE Y [US] ET AL) 11 January 2000 (2000-01-11) column 13, line 62 - column 14, line 6 column 10, line 62 - column 11, line 5 column 32, line 5 - line 10</p>	1-10,14, 15

INTERNATIONAL SEARCH REPORT

International application No.
PCT/EP2012/002721

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.

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(partially)

A bioactive ceramic nanocomposite material suitable for a dental implant, comprising:
a plurality of first grains, the first grains comprising calcium phosphate and having an average grain size of one micron or less, the calcium phosphate being present in the ceramic nanocomposite material in an amount in the range of 10% by weight to 70% by weight based on the total weight of the bioactive ceramic nanocomposite material; and
a plurality of second grains dynamic-sintered to said plurality of first grains, the second grains comprising a ceramic and having an average grain size of one micron or less, the ceramic being selected from the group consisting of zirconia .

2. claims: 1-15(partially)

A bioactive ceramic nanocomposite material suitable for a dental implant, comprising:
a plurality of first grains, the first grains comprising calcium phosphate and having an average grain size of one micron or less, the calcium phosphate being present in the ceramic nanocomposite material in an amount in the range of 10% by weight to 70% by weight based on the total weight of the bioactive ceramic nanocomposite material; and
a plurality of second grains dynamic-sintered to said plurality of first grains, the second grains comprising a ceramic and having an average grain size of one micron or less, the ceramic being selected from the group consisting of alumina .

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2012/002721

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 6013591 A	11-01-2000	US RE39196 E1 US 6013591 A	18-07-2006 11-01-2000
