Title: DESIGN METHODOLOGY FOR TISSUE ENGINEERING SCAFFOLDS AND BIOMATERIAL IMPLANTS

Abstract: A design methodology is provided for creating biomaterial scaffolds optimized for in vivo function with any 3D anatomic shape. The method creates all designs using voxel based design techniques. It also provides for optimization of implant and scaffold microstructure to best match functional and biofactor delivery (including cells, genes and proteins) requirements. The voxel based design techniques readily allow combination of any scaffold or implant microstructure database with any complex 3D anatomic shape created by CT or MRI scanners. These design can be readily converted to formats for layered manufacturing or casting.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
   IPC(7) : G06F 19/00
   US CL. : 702/19
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. : 702/19

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 6,013,853 (ATHANASIOU et al.) 11 January 2000, column 10-11</td>
<td>1-47</td>
</tr>
<tr>
<td>A</td>
<td>US 6,143,293 (WEISS et al.) 07 November 2000, columns 1-5</td>
<td>1-47</td>
</tr>
</tbody>
</table>

☐ 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)
  *G* 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 principles 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

*A* document member of the same patent family

Date of the actual completion of the international search
02 November 2002 (02.11.2002)

Date of mailing of the international search report
26 FEB 2003

Name and mailing address of the ISA/US
Commissioner of Patents and Trademarks
Box PCT
Washington, D.C. 20231

Facsimile No. (703)305-3230

Authorized officer
John S. Brusca

Telephone No. 703 308-0596

Form PCT/ISA/210 (second sheet) (July 1998)
INTERNATIONAL SEARCH REPORT

Box I Observations where certain claims were found unsearchable (Continuation of Item 1 of first sheet)

This international report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1.☐ Claim Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2.☐ Claim 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.☐ Claim Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of Item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:
Please See Continuation 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.:

Remark on Protest ☐ The additional search fees were accompanied by the applicant’s protest.

☐ No protest accompanied the payment of additional search fees.

Form PCT/ISA/2/10 (continuation of first sheet(1)) (July 1998)
BOX II. 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, claim(s) 1-20, drawn to a method of designing an implantable member.

Group II, claim(s) 21-28, drawn to a method of designing a tissue scaffold with a desired stiffness.

Group III, claim(s) 29-31, drawn to a method of designing a tissue scaffold with a desired vascularization.

Group IV, claim(s) 33-43, drawn to a method of designing a drug or gene delivery scaffold.

Group V, claim(s) 44-47, drawn to a method of generating a scaffold design.

The inventions listed as Groups I-V 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 special technical features for the following reasons: PCT Rule 13.1 and Annex B do not provide for unity of invention between two or more different products, methods of making, or methods of use that share a special technical feature. Groups I-V are each drawn to different methods that comprise different steps and produce different results.

Continuation of B. FIELDS SEARCHED Item 3:
Medline, Biosis, US Patents, Derwent WPI
search terms: implant, design, shape, scaffold