PATENT COOPERATION TREATY

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INTERNATIONAL SEARCHING AUTHORITY

To:

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PCT

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43*bis*.1)

Date of mailing
(day/month/year) see form PCT/ISA/210 (second sheet)

Applicant's or agent's file reference
see form PCT/ISA/220

FOR FURTHER ACTION
See paragraph 2 below

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/IB2018/056389	23.08.2018	30.08.2017

International Patent Classification (IPC) or both national classification and IPC
INV. B33Y50/00 B29C64/386 B29C64/10 H04N1/40

Applicant
ECOLE POLYTECHNIQUE FEDERALE DE LAUSANNE (EPFL)

1. This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement
- ☒ Box No. VI Certain documents cited
- ☒ Box No. VII Certain defects in the international application
- ☒ Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will usually be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notifed the International Bureau under Rule 66.1*bis*(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

Name and mailing address of the ISA:	Date of completion of this opinion	Authorized Officer
European Patent Office P.B. 5818 Patentlaan 2 NL-2280 HV Rijswijk - Pays Bas Tel. +31 70 340 - 2040 Fax: +31 70 340 - 3016	see form PCT/ISA/210	Visser, Michelle L. Telephone No. +31 70 340-0

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/IB2018/056389

Box No. I Basis of the opinion

1. With regard to the **language**, this opinion has been established on the basis of:

   ☒ the international application in the language in which it was filed.

   ☐ a translation of the international application into , which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1 (b)).

2. ☐ This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43*bis*.1(a))

3. ☐ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of a sequence listing:

   a. ☐ forming part of the international application as filed:

      ☐ in the form of an Annex C/ST.25 text file.

      ☐ on paper or in the form of an image file.

   b. ☐ furnished together with the international application under PCT Rule 13*ter*.1(a) for the purposes of international search only in the form of an Annex C/ST.25 text file.

   c. ☐ furnished subsequent to the international filing date for the purposes of international search only:

      ☐ in the form of an Annex C/ST.25 text file (Rule 13*ter*.1(a)).

      ☐ on paper or in the form of an image file (Rule 13*ter*.1(b) and Administrative Instructions, Section 713).

4. ☐ In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that forming part of the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments:

Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	7, 10, 11, 18-26, 28, 33, 35, 36, 38-43, 45
	No:	Claims	1-6, 8, 9, 12-17, 27, 29-32, 34, 37, 44, 46, 47
Inventive step (IS)	Yes:	Claims	
	No:	Claims	1-47
Industrial applicability (IA)	Yes:	Claims	1-47
	No:	Claims	

2. Citations and explanations

see separate sheet

Box No. VI Certain documents cited

1. Certain published documents (Rules 43*bis*.1 and 70.10)

and / or

2. Non-written disclosures (Rules 43*bis*.1 and 70.9)

see form 210

Box No. VII Certain defects in the international application

The following defects in the form or contents of the international application have been noted:

see separate sheet

Box No. VIII Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

see separate sheet

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

Reference is made to the following documents:

D1 Brett Kelly ET AL: "Computed Axial Lithography (CAL): Toward Single Step 3D Printing of Arbitrary Geometries",
, 16 May 2017 (2017-05-16), XP055531615,
Retrieved from the Internet:
URL:https://arxiv.org/pdf/1705.05893.pdf
[retrieved on 2018-12-07]

D2 WO 2016/173474 A1 (WU XIANG [CN]) 3 November 2016 (2016-11-03); & US 2018/153205 A1 (WU XIANG [CN]) 7 June 2018 (2018-06-07) *

D3 EP 3 018 531 A1 (TECH UNIVERSITÄT BERLIN [DE]) 11 May 2016 (2016-05-11)

* US2018/153205 A1 is provided as an English language translation of the prior art document WO 2016/173474 A1. All references to passages of D2 refer to passages of this English translation.

1 **Independent claims 1, 8 and 44, Article 33(2) PCT**

The present application does not meet the criteria of Article 33(1) PCT, because the subject-matter of claims 1, 8 and 44 is not new in the sense of Article 33(2) PCT.

1.1 Concerning claim 1, D1 discloses:

A method for producing a three-dimensional object **(abstract: "In this work we develop the principles for an approach for single exposure 3D printing o arbitrarily defined geometries")** comprising:
a. computing a sequence of back-projections describing the three-dimensional object to be formed from different orientation angles of said object **(section 2.1 "Computed Tomography Reconstruction": P(x,θ), the angular projections of the image are computed and backprojection algorithm applied)**,
b. defining a sequence of patterns of light using said back-projections **(section 2.1 "Computed Tomography Reconstruction: this algorithmic**

backprojection then motivates a technique to physically backproject the computer radon transform at each angle and directly construct desired 3D dose volumes), and
c. irradiating with each of said patterns of light at the respective corresponding orientation angle and according to the defined sequence a photoresponsive material that is capable of alteration of its material phase upon irradiation by light, thereby creating a three-dimensional distribution of alterations within the photoresponsive medium which physically reproduces said three-dimensional object, thereby creating the three-dimensional object **(section 5.1 "3D CAL Printing System" and section 5.3 "3D Results")**.

Therefore claim 1 is not new.

1.2 Concerning claim 8, D1 discloses:

A system for producing a three-dimensional object from a photoresponsive material **(figure 14; section 5.1 "3D CAL Printing System")**, the system comprising:
a first projection unit capable of emitting controlled spatial patterns of light **(figure 14: DLP projector; section 5.1 "3D CAL Printing System")**;
a means for computing a sequence of back-projections describing the three-dimensional object to be formed from different orientation angles of said object; said back-projections being used to define said controlled patterns of light **(section 5.1 "3D CAL Printing System" and section 2.1 "Computed Tomography Reconstruction")**;
a vessel optically transparent to said patterns of light, said vessel intended to contain a volume of photoresponsive material, and said vessel and the intended photoresponsive material defining a build volume **(figure 14; section 5.1 "3D CAL Printing System. It is implicit that the vessel is transparent to the light patterns)**;
whereby the first projection unit is arranged in the system to irradiate said build volume with said controlled patterns of light **(figure 14: DLP projector; section 5.1 "3D CAL Printing System")**; and
a direction varying means operatively associated with said first projection unit, for controllably varying a direction of incidence of said patterns of light relative to said build volume, either by rotating the build volume within the field of illumination of the first projection unit, or by rotating the first projection unit relative to the build volume, or a combination of both of these rotations, and for executing the computed sequence of back-projections by irradiating the photoresponsive medium with the controlled patterns of light from directions

corresponding to the different orientation angles thereby creating a three-dimensional distribution of alterations of the photoresponsive medium, and creating the three-dimensional object **(figure 14: rotating mount; section 5.1 "3D CAL Printing System")**.

Therefore claim 8 is not new.

1.3 For the sake of completeness, it is noted that the subject-matter of claims 1 and 8 also lacks novelty in view of document D2 (paragraphs 80-84 and 97-100).

1.4 Claim 44 is directed to: A formed biological organ created as a result of a biological process of cell growths from said biological cells in said formed three dimensional object produced following either claim 39 or claim 42.

As discussed in the clarity objection in Item VIII below, claim 44 seems to be defined in terms of the process by which the organ is made, and does not comprise any features which allow for the claimed organ to be distinguished from any other organ. Consequently, according to Chapter 5.26 of the PCT ISPE Guidelines, noting that the EPO applies option A5, 26[1] of the Appendix to Chapter 5, claim 44 lacks novelty in view of e.g. the organ disclosed in paragraph 17 of D3.

2 **Dependent claims**

Dependent claims 2-7, 9-43 and 45-47 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT in respect of novelty and/or inventive step.

2.1 Claim 2 is directed to details of the computation of the back-projections, which are disclosed in section 2.1 of D1.

2.2 Claims 3-6 and 13-16 are directed to details of the photoresponsive material, which are either explicitly or implicitly disclosed in sections 3.1, 3.2 and 5.2, and figure 15 of D1.

2.3 Claims 7 and 33 are directed to details of producing a multi-material object, which are disclosed in paragraphs 84 and 85 of D3. It would be obvious to the skilled person to combine these features with the method/system of D1.

2.4 Claims 9-12, 17, 19 (in part) and 20 (in part) are directed to details of the projection unit. The features of claims 9, 12 and 17 are disclosed in section 5.1 and figure 14 of D1. Although the light source of the DLP projector is not

disclosed in D1, providing a laser, multiple lasers, a LED or LED array merely involves selecting one of several straightforward possibilities and does not involve an inventive step.

2.5 Claims 18, 19 (in part), 20 (in part) and 21 are directed to details of providing two projection units capable of generating patterns of light at different wavelengths, which is disclosed in paragraphs 82 and 84-85 of D3. It would be obvious to the skilled person to combine these features with the system of D1. Moreover, claims 22-23 are directed to details of known photoresponsive materials in a system having two projection unit. Selecting an appropriate photoresponsive material falls within the scope of the usual practice of the skilled person, and does not confer an inventive step.

2.6 Claims 24 and 39 are directed to loading the photoresponsive material with biological cells, which is disclosed in paragraph 84 of D3. It would be obvious to the skilled person to combine this feature with the system of D1. Moreover, claims 40-43 are directed to further trivial details of the cells/material, which do not involve an inventive step.

2.7 Claims 25-26 and 45 relate to trivial implementation details which do not involve and inventive step over the disclosure of D1.

2.8 Claim 27 is directed to details of the spatial light patterns which are disclosed in section 2.1 of D1.

2.9 Claim 28 is directed to details of providing a temperature controlling means, which is disclosed in paragraph 88 of D3. It would be obvious to the skilled person to combine this feature with the method/system of D1.

2.10 Claim 29 is directed to details of vertically displacing the build volume relative to the field of illumination, which is disclosed insection 5.3 of D1.

2.11 Claims 30-32 are directed to details of applying corrections for various effects, which are disclosed in sections 2.2, 2.3, 4.1 and 4.2 of D1.

2.12 Claims 34 and 35 are directed to details of recording alterations of the photoresponsive medium to provide feedback.The features of claim 34 are disclosed in section 4.2 of D1, and the features of claim 35 seem to relate to trivial implementation details, which do not involve an inventive step.

2.13 Claim 36 is directed to details of automating the injection and removal of the photoresponsive material, which are disclosed in paragraph 83 of D3. It would be obvious to the skilled person to combine this feature with the system of D1.

2.14 Claim 37 is directed is directed to providing means for extracting the formed object, which is at least implicitly disclosed in section 5.3 of D1.

2.15 Claim 38 is directed to the vessel being sterilized, which is disclosed in paragraphs 41-43 of D3. It would be obvious to the skilled person to combine this feature with the system of D1.

2.16 Claim 46 is directed to the formed object having anisotropic mechanical features, which is disclosed in section 5.3 of D1.

2.17 Claim 47 is directed to obtaining a 3D scan of an object before forming a copy of the object, which is disclosed in paragraphs 124-129 of D2.

Re Item VI

Certain documents cited

Application No Patent No	Publication date *(day/month/year)*	Filing date *(day/month/year)*	Priority date *(valid claim)* *(day/month/year)*
WO 2018/208378	15/11/2018	27/03/2018	12/05/2017

WO 2018/208378 is a PCT application which bears a priority date earlier than the filing date of the present application, but has been published later than that date. Consequently, the content of this application may become relevant should the present application enter the regional phase before the European Patent Office. In more detail, paragraphs 22-37 and figures 1-3 of this document could be detrimental to the novelty of claims 1-4, 8-14,17, 27 and 37.

Re Item VII

Certain defects in the international application

The independent claims are not in the two-part form in accordance with Rule 6.3(b) PCT.

The features of the claims are not provided with reference signs placed in parentheses (Rule 6.2(b) PCT).

Contrary to the requirements of Rule 5.1(a)(ii) PCT, the relevant background art disclosed in D1-D3 is not mentioned in the description, nor are these documents identified therein.

Re Item VIII

Certain observations on the international application

The application does not meet the requirements of Article 6 PCT, because claims 1, 2, 8 and 44 are not clear.

The scope of protection sought by claim 44 is highly unclear. This claim is directed to a formed biological organ. However, it is defined in terms of a vague method, namely "created as a result of a biological process of cell growths", and the cell growths are from cells "in said formed three dimensional object produced following either claim 39 or claim 42". However, claims 39 and 42 are directed to a system, and not a method of producing a three dimensional object. Hence, claim 44 seems to be directed to a product-by-process claim, but the method of manufacture is ill-defined. In any case, it is not apparent how the claimed organ could be distinguished from any other organ, consequently the limitations sought by the claim are unclear.

Moreover, the term "back-projections" in claims 1, 2 and 8 is unclear. Although "back-projection" is a well-defined term in the field of tomography, in which a system can be estimated from a number of projections, in claims 1,2 and 8, there are no projections/ images of an object from which to form back-projections.