

**PATENT COOPERATION TREATY**

**PCT**

**INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY**

(Chapter I of the Patent Cooperation Treaty)

(PCT Rule 44bis)

Applicant's or agent's file reference <b>121-145b</b>	<b>FOR FURTHER ACTION</b>		See item 4 below
International application No. <b>PCT/IB2017/055290</b>	International filing date ( <i>day/month/year</i> ) <b>03 September 2017 (03.09.2017)</b>	Priority date ( <i>day/month/year</i> ) <b>04 September 2016 (04.09.2016)</b>	
International Patent Classification (8th edition unless older edition indicated) <b>See relevant information in Form PCT/ISA/237</b>			
Applicant <b>ARIEL SCIENTIFIC INNOVATIONS LTD.</b>			

<p>1. This international preliminary report on patentability (Chapter I) is issued by the International Bureau on behalf of the International Searching Authority under Rule 44 bis.1(a).</p> <p>2. This REPORT consists of a total of 9 sheets, including this cover sheet.</p> <p>In the attached sheets, any reference to the written opinion of the International Searching Authority should be read as a reference to the international preliminary report on patentability (Chapter I) instead.</p>																								
<p>3. This report contains indications relating to the following items:</p> <table> <tr> <td><input checked="" type="checkbox"/></td> <td>Box No. I</td> <td>Basis of the report</td> </tr> <tr> <td><input type="checkbox"/></td> <td>Box No. II</td> <td>Priority</td> </tr> <tr> <td><input type="checkbox"/></td> <td>Box No. III</td> <td>Non-establishment of opinion with regard to novelty, inventive step and industrial applicability</td> </tr> <tr> <td><input type="checkbox"/></td> <td>Box No. IV</td> <td>Lack of unity of invention</td> </tr> <tr> <td><input checked="" type="checkbox"/></td> <td>Box No. V</td> <td>Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement</td> </tr> <tr> <td><input type="checkbox"/></td> <td>Box No. VI</td> <td>Certain documents cited</td> </tr> <tr> <td><input type="checkbox"/></td> <td>Box No. VII</td> <td>Certain defects in the international application</td> </tr> <tr> <td><input checked="" type="checkbox"/></td> <td>Box No. VIII</td> <td>Certain observations on the international application</td> </tr> </table> <p>4. The International Bureau will communicate this report to designated Offices in accordance with Rules 44bis.3(c) and 93bis.1 but not, except where the applicant makes an express request under Article 23(2), before the expiration of 30 months from the priority date (Rule 44bis .2).</p>	<input checked="" type="checkbox"/>	Box No. I	Basis of the report	<input type="checkbox"/>	Box No. II	Priority	<input type="checkbox"/>	Box No. III	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability	<input type="checkbox"/>	Box No. IV	Lack of unity of invention	<input checked="" type="checkbox"/>	Box No. V	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement	<input type="checkbox"/>	Box No. VI	Certain documents cited	<input type="checkbox"/>	Box No. VII	Certain defects in the international application	<input checked="" type="checkbox"/>	Box No. VIII	Certain observations on the international application
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	Date of issuance of this report <b>05 March 2019 (05.03.2019)</b>
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# PATENT COOPERATION TREATY

From the  
INTERNATIONAL SEARCHING AUTHORITY

# PCT

WRITTEN OPINION OF THE  
INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43*bis*.1)

To:  <p style="text-align: center;">GUR Erez POB 1372 Weizman Street 44113 Kfar Saba Israel</p>		Date of mailing ( <i>day/month/year</i> ) <span style="float: right;">28 Nov 2017</span>
Applicant's or agent's file reference 121-145b		<b>FOR FURTHER ACTION</b> See paragraph 2 below
International application No. PCT/IB2017/055290	International filing date ( <i>day/month/year</i> ) 03 Sep 2017	Priority date ( <i>day/month/year</i> ) 04 Sep 2016
International Patent Classification (IPC) or both national classification and IPC IPC (2017.01) B01D 71/68 B01D 69/10 B01D 71/50 B01D 71/06 B01D 67/00		
Applicant ARIEL SCIENTIFIC INNOVATIONS LTD.		

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 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 notified 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: Israel Patent Office Technology Park, Bldg.5, Malcha, Jerusalem, 9695101, Israel Facsimile No. 972-2-5651616	Date of completion of this opinion 28 Nov 2017	Authorized officer KORBAKOV Nina  Telephone No. 972-2-5651757
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WRITTEN OPINION OF THE  
INTERNATIONAL SEARCHING AUTHORITY

International application No.  
PCT/IB2017/055290

Box No. I Basis of this 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 43bis.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims <u>7-10,12,18,19,31-45,48-50</u>	YES
	Claims <u>1-6,11,13-17,20-30,46,47</u>	NO
Inventive step (IS)	Claims _____	YES
	Claims <u>1-50</u>	NO
Industrial applicability (IA)	Claims <u>1-50</u>	YES
	Claims _____	NO

2. Citations and explanations:

**Reference is made to the following documents:**

**D1:** Eishun Tsuchida et al., 'Effect of Polymer Matrix on the Oxygen Diffusion via a Cobalt Porphyrin Fixed in a Membrane', *Macromolecules*, 24, pp. 6306-6309, 1991.

**D2:** Hiroyuki NISHIDE et al., 'High Oxygen Permeation and Persistent Oxygen-Carrying in a Poly(vinylimidazole-co-fluoroalkyl methacrylate)-Cobaltporphyrin Membrane', *Polymer Journal*, Vol. 33 (10), pp. 807-811, 2001.

**D3:** Yoshio Okahata et al., 'Highly Selective Transport of Molecular Oxygen in a Polymer Containing a Cobalt Porphyrin Complex as a Fixed Carrier', *Macromolecules*, 19, pp. 494-496, 1986.

**D4:** JUIN-YIH LAI et al., 'Effect of Nonsolvent/Oxygen Carrier Additives on Gas Separation Performance of Polycarbonate Membranes', *SEPARATION SCIENCE AND TECHNOLOGY*, 32(5), pp. 925-937, 1997.

**D5:** WO2010086630 (A1), (SANDRU MARIUS [NO]; KIM TAEK-JOONG [NO]; HAEGG MAY-BRITT [NO]), 05 August 2010.

**D6:** Mathias Ulbricht, 'Advanced functional polymer membranes', *Polymer* 47, pp. 2217 -2262, 2006.

**2.1 Novelty**

The present application does not meet the criteria of Article 33(1) PCT, because the subject-matter of claims 1-6,11,13-17,20-30,46,47 is described in the prior art (Article 33(2) PCT).

The proviso in claim 1 regarding "... selectively-permeable membranes comprise thinner regions of said polymer matrix and thicker regions of said polymer matrix" is unclear (see also Box VIII) since the terms "thinner" and "thicker" are relative terms and, consequently, unclear. Therefore, said proviso is not considered regarding novelty in the present report.

**2.1.1 Regarding claim 1**

D1 discloses a specific and facilitated transport of oxygen through a polymer (copolymer) membrane comprising poly( butyl methacrylate-*co*-1-vinylimidazole), poly(octyl methacrylate-*co*-1-vinylimidazole), and poly(lauryl methacrylate-*co*-1-vinylimidazole) and containing [ $\alpha$ -mono(*o*-methacrylamidophenyl)-  $\alpha$ ,  $\alpha$ ,  $\alpha$  -tris(*o*-pivalamidophenyl)porphinato]cobalt (CoMPP) complex as a fixed oxygen carrier. According to D1, the polymer membrane was prepared by combining CoMPP with the copolymers in their chloroform solution, and the chloroform solution was carefully cast on a Teflon plate under an oxygen-free atmosphere and dried in vacuo to yield a transparent and flexible membrane with thickness of ca. 60  $\mu\text{m}$  (p. 6306, (Introduction, Experimental Section)).

Claim 1 in the present application discloses selectively-permeable membranes/support structure having first and second sides, wherein the polymeric membrane allows passage of gases through said membrane by simple diffusion.

D1 expresses a diffusive mobility of a permeate molecule in a polymer membrane by four kinds of pathway, wherein one of them is the physical permeation (p. 6307, 6308). Thus, D1 estimates simple diffusion of gas through the polymer membrane as it claimed in claim 1.

It should be noted that D1 studied an effect of the upstream and downstream oxygen pressure on the oxygen permeability coefficient for the CoMPP membranes (p. 6307, 6308). Therefore, according to D1 the polymer membrane exists at plurality of pressures.

D2 discloses a high oxygen permeation membrane having cobaltporphyrin (CoP) as an oxygen-carrier complex with poly(vinylimidazole-*co*-fluoropentyl methacrylate) (FIm) matrix (polymer ligand), wherein CoP complex binds oxygen reversibly (p. 807, 808).

Said membrane was prepared by casting DMF solution of poly(vinylimidazole-*co*-fluoropentyl methacrylate) (FIm) and cobaltporphyrin (CoP) on a microporous flat membrane (made from polypropylene and polyethylene, pore dimensions,  $0.05 \times 0.19 \mu\text{m}$ ; porosity, 0.43; thickness, 25  $\mu\text{m}$ ), under nitrogen atmosphere, followed by drying in vacuo, wherein the thickness of active CoP-FIm layer is 20  $\mu\text{m}$  (p. 808, (Membrane Preparation) ).

D2 describes oxygen permeation through the polymer membranes at various upstream oxygen pressures (p. 809, 810, figure 2).

D3 describes a polymer membrane containing a cobalt porphyrin complex (CoPIm) as a fixed carrier and having high selective transport of oxygen, wherein CoPIm complex binds oxygen rapidly and reversibly (p. 494,495).

Said polymer membrane was prepared by homogeneously dispersing in a toluene solution of poly(butyl methacrylate) the CoPIm complex, wherein poly(butyl methacrylate) and CoPIm was casted on a Teflon plate under an atmosphere without oxygen, followed by drying in vacuo. Thickness of said membrane is 20  $\mu\text{m}$ .

D4 discloses permeable and selective to oxygen/nitrogen porous polycarbonate (PC)

membranes comprising N,N'-dialicylidene ethylene diamine cobalt (CoSalen) carrier. D4 explains that N,N'-Dimethylformamide (DMF) and CoSalen were added into the casting solution comprising PC to improve (20-fold improvement) both the gas permeability and oxygen/nitrogen selectivity of PC membranes (p. 926, 937, abstract).

Said membranes were formed by casting the solution onto a glass plate at room temperature. The membranes were dried in vacuum for 24 hours (p. 927).

D5 provides a polymer (polyvinylamine (PVAm)) membrane fixed carrier (amino groups carrier) suitable for separating a gas (carbon dioxide) from a gas mixture, wherein PVAm has an average molecular weight (Mw) at least 50,000, preferably, at least 100,000, carried on a porous support (pores size is of 0.10 to 10  $\mu\text{m}$ ).

The thickness of said support on which the membrane can be carried is from 50 to 500  $\mu\text{m}$ , and said PVAm membrane thickness is 1.2  $\mu\text{m}$  (p. 3, lines 22-30, p. 6, Example 3). Further, D5 mentions that said polymer membrane is able to operate at elevated gas pressures (p. 10, lines 11-13).

In light of the above, the subject-matter of claim 1 is not novel in view of D1-D5 (Article 33(2) PCT).

The subject-matter of dependent claims 2-6,11,13-17,20-30 is not considered novel in view of D1-D5 (Article 33(2) PCT), wherein features such as a presence of parallel first and second sides of the membrane/supporting structure, equidistance of said membrane from first and second sides (as claimed in said claims) are considered as inherent properties of said materials.

#### 2.1.2 Regarding claim 33

None of the cited documents discloses the polymer membrane preparation process comprising step (iv) as it claimed in claim 33.

Therefore, the subject-matter of claim 33 is novel (Article 33(2) PCT).

Thus, the subject-matter of claims 34-45, 48-50 is considered novel (Article 33(2) PCT).

#### 2.1.3 Regarding claim 46

As it was mentioned above, documents D1-D3 disclose a non-biological oxygen permeable membrane having cobalt porphyrin complex that binds oxygen reversibly. Since phthalocyanines are structurally related to porphyrins, the subject-matter of claim 46 is not novel (Article 33(2) PCT).

#### 2.1.4 Regarding claim 47

D4 discloses permeable and selective to oxygen/nitrogen porous polycarbonate (PC) membranes comprising N,N'-dialicylidene ethylene diamine cobalt (CoSalen) carrier. D4

explains that N,N'-Dimethylformamide (DMF) and CoSalen were added into the casting solution comprising PC to improve both the gas permeability and oxygen/nitrogen selectivity of polycarbonate (PC) membranes (p. 926, 931,932, abstract, figure 1).

The fact that said membrane comprising first and second sides is an inherent property of the material.

Thus, the subject-matter of claim 47 is not novel (Article 33(2) PCT).

#### 2.1.5 Regarding claims 7-10,12,18,19,31,32

The subject-matter of said claims is not mentioned in D1-D5. Moreover, it has not been found a document that discloses the subject-matter of said claims.

Therefore, the subject-matter of said claims is new (Article 33(2) PCT).

### **2.2 Inventive step**

The present application does not meet the criteria of Article 33(1) PCT, because the subject-matter of claims 1-50 does not fulfill the requirements of Article 33(3) PCT.

#### 2.2.1 Regarding claims 1-6,11,13-17,20-30,46,47

The subject-matter of claims 2-6,11,13-17,20-30 ,46,47 is described in documents D1-D5 (see section 2.1). Therefore, the subject-matter of said claims lacks inventive step (Article 33(2) PCT).

It should be noted, even if novelty of said claims is proved, in the absence of unexpected results, an inventive step can not be acknowledged.

#### 2.2.2 Regarding claims 7-10,12,18,19,31,32

The additional features in claims 7-10,12,18,19 are considered as routine experimentation for the skilled art.

The subject-matter of claims 31,32 is considered as obvious for the skilled person in search for an optimal polymer membrane.

Therefore, the subject-matter of claims 7-10,12,18,19,31,32 it is not inventive (Article 33(3) PCT).

#### 2.2.3 Regarding claims 33-45

The subject-matter of claims 33-45 does not contain any additional features, which, in combination with the features of any claim to which it refers, meet the requirements of the PCT in respect of inventive step (Article 33(3) PCT).

#### 2.2.4 Regarding claims 48-50

D6 provides an overview on the development of polymeric membranes having advanced or novel functions in the various membrane separation processes for liquid and gaseous mixtures

(gas separation, reverse osmosis, pervaporation, nanofiltration, ultrafiltration, microfiltration) and in other important applications of membranes such as biomaterials, catalysis (including fuel cell systems) or lab-on-chip technologies (abstract). Thus, for the skilled person it would be obvious to apply the polymer membranes of D1-D5 in a variety of devices and in a method of transporting gas molecules according to D6. The subject-matter of claims 48-50 lacks inventive step (Article 33(3) PCT).

### **2.3 Industrial applicability**

The subject-matter of claims 1-50 is considered to be industrially applicable under Article 33 (4) PCT.



**WRITTEN OPINION OF THE  
INTERNATIONAL SEARCHING AUTHORITY**

International application No.

PCT/IB2017/055290

**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:

1. The terms "thinner" and "thicker" used in claim 1 are relative, vague and broad and leave the reader in doubt as to the meaning of the technical feature to which they refer, thereby rendering the definition of the subject-matter of said claim unclear, Article 6 PCT.