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(71) Applicant (for all designated States except US):  
**NANOHO, INC.** [US/US]; 570 Westwood Plaza, Ste 6532, Building 114, MC 722710, Los Angeles, CA 90095-7227 (US).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **KURTH, Christopher, James** [US/US]; 8294 Drexel Court, Eden Prairie, MN 55347 (US). **KOEHLER, Jeffrey, Alan** [US/US]; 712 E Walnut St #503, Pasadena, CA 91101 (US). **ZHOU, Meijuan** [CN/US]; 34117 Frederick Ln., Fremont, CA 94555 (US). **HOLMBERG, Brett, Anderson** [US/US]; 1851 Pandora Ave, Los Angeles, CA 92507

[Continued on next page]

(54) Title: HYBRID NANOPARTICLE TFC MEMBRANES

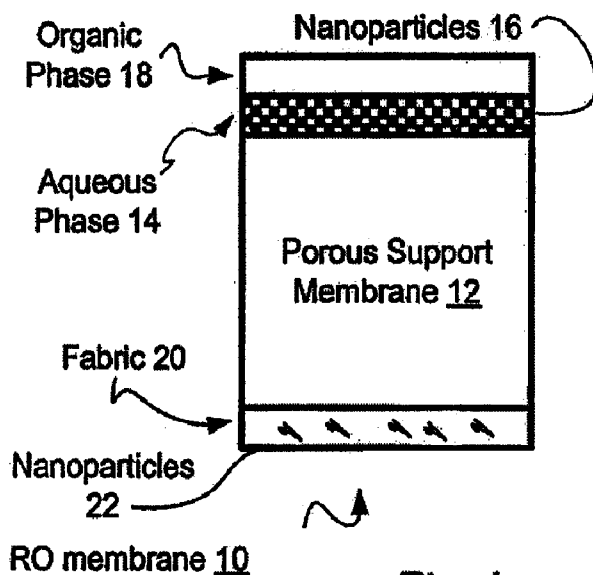


Fig. 1

(57) Abstract: Reverse osmosis membranes made by interfacial polymerization of a monomer in a nonpolar (e.g. organic) phase together with a monomer in a polar (e.g. aqueous) phase on a porous support membrane. Interfacial polymerization process is disclosed for preparing a highly permeable RO membrane, comprising: contacting on a porous support membrane, a) a first solution containing 1,3-diaminobenzene, and b) a second solution containing trimesoyl chloride, wherein at least one of solutions a) and b) contains nanoparticles when said solutions are first contacted, and recovering a highly permeable RO membrane.

WO 2009/129354 A3





(US). **BURK, Robert, Leon** [US/US]; 2017 Fairview Avenue East, Suite G, Seattle, WA 98102-3590 (US).

(74) **Agent: HAHL, Robert, W.**; Neifeld IP Law, PC, 4813-B Eisenhower Ave., Alexandria, VA 22304 (US).

(81) **Designated States** (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

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**Published:**

- 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))

(88) **Date of publication of the international search report:**  
28 January 2010

## INTERNATIONAL SEARCH REPORT

International application No.  
**PCT/US2009/040732****A. CLASSIFICATION OF SUBJECT MATTER***B01D 71/00(2006.01)i, B01D 69/10(2006.01)i, B01D 61/02(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)

IPC B01D 31/00, 13/00, 71/16, 63/00, 71/09, B29C 39/00

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)  
eKOMPASS(KIPO internal) "interfacial polymerization, permeable RO membrane, 1,3-diaminobenzene, trimesoyl chloride, porous support membrane, dispersed nanoparticles, metaphenylenediamine"**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 04039440 A (John E. Cadotte, etc.) 02 Aug. 1977 See abstract, columns 1~8 and claims 1~4	1~104
A	US 04902424 A (Wolfgang J. Wrasidlo, etc) 20 Feb. 1990 See abstract, columns 1~21 and claims 1~13	1~104
A	KR 1020050077141 A (KOREA OCEAN RES. & DEVELOPMENT INS.) 01 Aug. 2005 See abstract, pages 1~4 and claims 1~5	1~104
P, X	US 2008/0237126 A1 (Eric. M.V.Hoek, etc) 02 Oct. 2008 See abstract, columns 1~21 and claims 1~25	1~104
P, X	US 2008/0149561 A1 (Benjamin Chu, etc) 26 Jun. 2008 See abstract, columns 1~14 and claims 1~60	1~11

 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

"&" 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, 139 Seonsa-ro, Seo-  
gu, Daejeon 302-701, Republic of Korea

Facsimile No. 82-42-472-7140

Authorized officer

CHO Jun Bae

Telephone No. 82-42-481-8292



INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2009/040732

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:

- I. Claims 1~11 directed an interfacial polymerization process for preparing a permeable RO membrane formed by reacting 1,3-diaminobenzene with trimesoyl chloride.
  
- II. Claims 12~81 directed a permeable RO membrane, or an interfacial polymerization process for said permeable RO membrane formed by reacting polyamine monomer with polyfunctional acyl halide monomer.
  
- III. Claims 82~104 directed a permeable RO membrane, or an interfacial polymerization process for said permeable RO membrane formed by reacting metaphenylene diamine with trimesoyl chloride.

- 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 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/US2009/040732**

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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