



(43) International Publication Date
5 January 2017 (05.01.2017)

- (51) International Patent Classification:
C07B 57/00 (2006.01) C07C 231/20 (2006.01)
- (21) International Application Number:
PCT/US2016/039505
- (22) International Filing Date:
27 June 2016 (27.06.2016)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:
62/185,891 29 June 2015 (29.06.2015) US
- (72) Inventor; and
(71) Applicant : CHACHISVILIS, Mirianas [US/US]; 4744
Keswick Court, San Diego, CA 92130 (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, BN, BR, BW, BY,
BZ, CA, CH, CL, 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, IR, IS, JP, KE, KG, KN, KP, KR,

KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG,
MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM,
PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC,
SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN,
TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

- (84) Designated States (unless otherwise indicated, for every
kind of regional protection available): ARIPO (BW, GH,
GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ,
TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU,
TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE,
DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU,
LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK,
SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ,
GW, KM, ML, MR, NE, SN, TD, TG).

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:
16 February 2017

(54) Title: CHIRAL SEPARATION AND ANALYSIS BY MOLECULAR PROPELLER EFFECT

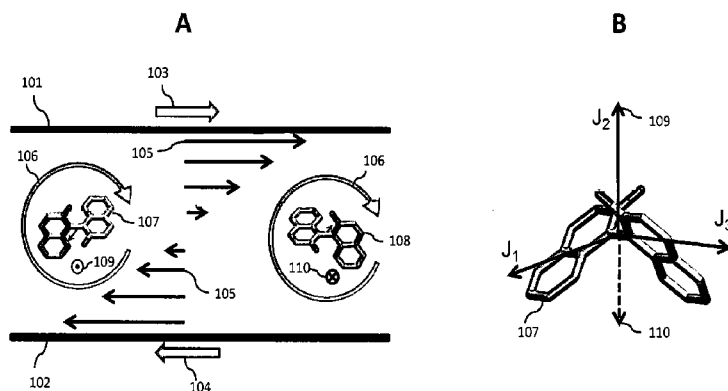


Figure 1

(57) Abstract: A method and a device for separation and analysis of chiral molecules are described. The method relies on using a fluid shear to induce molecular rotation and the molecular propeller effect to transform rotational motion into translation motion of opposite direction for counterpart enantiomers. The direction of motion of each enantiomer is used to determine its absolute configuration by comparing the direction value with theoretically calculated one. The device uses multiple moving surfaces or pressure induced flows to induce shear flow condition in the solution to separate enantiomers.



INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 16/39505

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - C07B 57/00; C07C 231/20 (2016.01)

CPC - C07B 57/00; C07C 231/20

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(8): C07B 57/00; C07C 231/20 (2016.01)

CPC: C07B 57/00; C07 C231/20

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
USPC: 137/808; 562/401

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

Google Scholar, Google Patents, PatBase

Enantiomer, optical isomer, chiral, separate, extract, rotate, cylinder, vessel, chamber, shear, flow, force, propel, propulsion

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---------------------------|---|--|
| X --- Y --- A | JP 2005-145887 A (Japan Science and Technology Agency) 09 June 2005 (09.06.2005); entire document, but especially: para [0001], para [0020], para [0022], para [0023], para [0032], para [0036]- para [0038], para [0043], para [0048], para [0055], para [0057], fig. 1 | 1-2; 4-6; 13; 15-16, 20 ----- 3; 14; 17 ----- 7-12 |
| X --- Y --- A | US 2008/0274555 A1 (Kibar et al.) 06 November 2008 (06.11.2008); entire document, but especially: para [0002], para [0009], para [0010], para [0037], para [0061], para [0070], para [0071], para [0076], para [0144], para [0173] | 18 ----- 3; 17; 19 ----- 7-12 |
| Y | Meinhardt et al. "Separation of Chiral Particles in Micro- or Nanofluidic Channels" Physical Review Letters, Vol 108 Issue 21 Article 214504 (23 May 2012): pages 214504-1 to 214504-5; entire document, but especially: page 214504-1 col 2 para 3, page 214504-2 col 1 para 3, page 214504-2 col 2 para 3 | 14 |
| Y | Hermans et al. "Vortex flows impart chirality-specific lift forces" Nature Communications, Vol 6 Article 5640 (12 January 2015): pages 1-8; entire document | 19 |
| A | Schamel et al. "Chiral Colloidal Molecules And Observation of The Propeller Effect" Vol 135 Issue 33 (24 July 2013): pages 12353-12359; entire document but especially: page 12354 col 1 para 1, page 12356 col 1 para 2 | 13 |

 Further documents are listed in the continuation of Box C.

* 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 another 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

5 January 2017

Date of mailing of the international search report

17 JAN 2017

Name and mailing address of the ISA/US

Mail Stop PCT, Attn: ISA/US, Commissioner for Patents
P.O. Box 1450, Alexandria, Virginia 22313-1450
Facsimile No. 571-273-8300

Authorized officer:

Lee W. Young

PCT Helpdesk: 571-272-4300
PCT OSP: 571-272-7774

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 16/39505

| C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT | | |
|---|--|-----------------------|
| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
| A | US 6,344,121 B1 (Stalcup et al.) 05 February 2002 (05.02.2002); col 2 lines 11-12, col 5 lines 57-61, col 6 lines 45-50, col 7 lines 3-4 | 7-12 |
| P, A | WO 2016/020532 A1 (University of Strasbourg) 11 February 2016 (11.02.2016); entire document | 1-20 |

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 16/39505

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:
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: Claims 1-6, 13-17 and 20 directed to a device and method for separating counterpart enantiomers comprising rotatable inner and outer members and a method for separating and analyzing counterpart enantiomers comprising rotating the enantiomers.

Group II: Claims 7-12 directed to a device for separating counterpart enantiomers comprising injection ports and a pump to drive flow.

Group III: Claims 18-19 directed to a theoretical molecular analysis method to determine the absolute configuration of an enantiomer.

---see extra 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 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.

Lack of Unity Invention

The inventions listed as Groups I-III 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:

SPECIAL TECHNICAL FEATURES

The invention of Group I includes the special technical feature of a device for separating counterpart enantiomers comprising a rotatable inner member, a rotatable outer member, and a method for separating counterpart enantiomers comprising rotating the enantiomers, not required by the claims of Groups II or III.

The invention of Group II includes the special technical feature of an injection port for injecting the solution of enantiomers, one or more injection ports for injecting solvents, a pump, and two or more ports for collecting the separated enantiomers, not required by the claims of Groups I or III.

The invention of Group III includes the special technical feature of performing molecular dynamics simulations on one or more of counterpart enantiomers to obtain molecular dynamics trajectories, not required by the claims of Groups I or II.

COMMON TECHNICAL FEATURES

Groups I and II share the common technical feature of a device for separating counterpart enantiomers from a mixture of a solution comprising a channel. However, this shared technical feature does not represent a contribution over prior art as being anticipated by JP 2005-145887 A to Japan Science and Technology Agency, which discloses of a device for separating counterpart enantiomers from a mixture of a solution comprising a channel (para [0021]: "Further, the separation device for enantiomers particles... forming the container from the annular flow path having a concentric inner and outer walls, it continues to flow the particles to separate into the annular channel"; para [0022]: "... the annular channel, by configuring the two cylinders which are arranged concentrically...").

Groups I and III share the common technical feature of propulsion of enantiomers due to a molecular propeller effect. However, this shared technical feature does not represent a contribution over prior art as being anticipated by US 2008/0274555 A1 to Kibar et al., who discloses that the propulsion of enantiomers is due to a molecular propeller effect (para [0070]: "...rotation of the external field causes a continuous torque to be applied to... enantiomers... during rotation their chiral features... will act as tiny propellers"; para [0071]: "Rotation of the tiny propellers by the field-applied torque is transformed into translational motion (i.e., linear motion) of the two enantiomers in opposite directions..."; i.e. the "tiny" propellers are molecular propellers).

As the common technical features were known in the art at the time of the invention, these cannot be considered special technical feature that would otherwise unify the groups.

Therefore, Groups I-III lack unity under PCT Rule 13 because they do not share a same or corresponding special technical feature.