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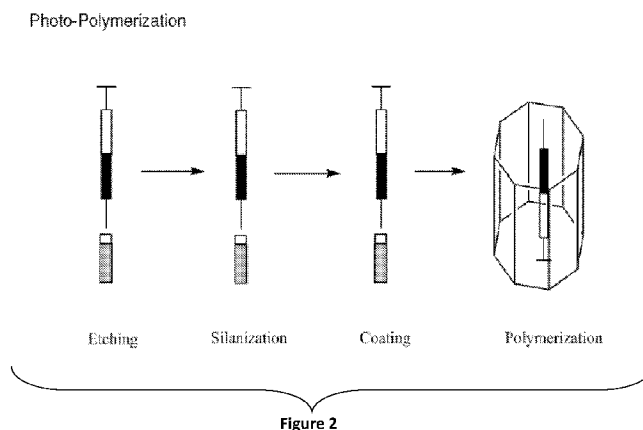
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13 March 2014

(54) **Title:** SYNTHESIS OF POLYMERIC IONIC LIQUIDS USING A PHOTOCHEMICAL POLYMERIZATION PROCESS



(57) **Abstract:** Photo-initiated polymeric ionic liquids, methods of making and methods of using the same are disclosed. A preferred embodiment for making a photo-initiated polymeric ionic liquid (P-PIL) coated support, comprises: mixing at least one ionic liquid (IL) monomer with at least one photo-initiator; at least partially coating a support with the mixture; and exposing the coated support to UV light to form a photo-initiated polymeric ionic liquid (P-PIL) coated support.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2013/043275

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - C08F 2/48 (2013.01)

USPC - 264/494

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) - C08F 2/00, 2/46, 2/48; C09D 4/00 (2013.01)

USPC - 264/405, 494; 427/487, 508

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

CPC - C08F 2/00, 2/46, 2/48; C09D 4/00 (2013.01)

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

Orbit, Google Patents, Google Scholar

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2011/046661 A1 (BARA et al) 21 April 2011 (21.04.2011) entire document	1, 2, 8-10, 14, 18, 22, 25, 34
Y		3-7, 11-13, 15-17, 19-21, 23, 24, 26
Y	US 2011/0151139 A1 (KIM et al) 23 June 2011 (23.06.2011) entire document	3-5
Y	KR 2006-0016413 A (PARK et al) 22 February 2006 (22.02.2006), see machine translation	5
Y	US 2011/0236295 A1 (ANDERSON et al) 29 September 2011 (29.09.2011) entire document	6, 7, 17, 19-21, 23, 24, 26
Y	US 2001/0031798 A1 (WRIGHT et al) 18 October 2001 (18.10.2001) entire document	11-13
Y	US 6,025,407 A (NAGY et al) 15 February 2000 (15.02.2000) entire document	15, 16

☐ 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

11 December 2013

Date of mailing of the international search report

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2013/043275

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:

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.:
1-26, 34

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.

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 need to be paid.

Group I: Claims 1-26 and 34 are drawn to a method of making a photo-initiated polymeric ionic liquid (P-PIL) coated support.

Group II: Claims 27-33 and 35-59 are drawn to a photo-initiated polymeric ionic liquid (P-PIL) coated support.

Group III: Claims 60-103 to methods and devices for separation, extraction or analysis of chemicals.

The inventions listed as Groups I through 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:

The special technical features of Group I, a method of making a photo-initiated polymeric ionic liquid support comprising mixing a ionic liquid monomer and a photo-initiator, coating the mixture on a support and then UV polymerizing, are not found in Groups II and III; the special technical features of Group II, a photo-initiated polymeric ionic liquid support comprising at least one cationic component and at least one anionic component, are not found in Groups I and III; and the special technical features of Group III, devices and methods for the separation, extraction, and analysis of chemicals, are not found in Groups I and II.

Groups I through III share the technical features of a photo-initiated polymeric ionic liquid (P-PIL) coated support, comprising: i) mixing at least one ionic liquid (IL) monomer with at least one photo-initiator; ii) at least partially coating a support with the mixture of step i); and iii) exposing the coated support of step ii) to UV light to form a photo-initiated polymeric ionic liquid (P-PIL) coated support. However, these technical features do not represent a contribution over the prior art.

Specifically, WO 2011/046661 A1 to Bara et al. teaches a method of making a photo-initiated polymeric ionic liquid (P-PIL) coated support (Para. [0216], Monomer 34 was mixed with photoinitiator (2-hydroxypropiophenone, 2 wt%) using a vortexer and poured onto a 250-mm diameter Supor® (100 µm polysulfone) supported material. The monomer on support was then pressed between two quartz plates covered with Rain-X (commercial hydrophobic, anti-stick coating for glass) to prevent sticking. After manually pressing to remove bubbles, the plates were clipped together using binder clips and placed in a UV oven (UVP Inc., CL-1000 Ultraviolet Crosslinker) and polymerized...supported membranes...), comprising: i) mixing at least one ionic liquid (IL) monomer (Para. [0216], Monomer 34...; Page 79, Scheme 8; Para. [0198], ...Monomer 34...; Para. [0199]; See Fig. 16; Para. [0091], Figure 16: Structure of a diol-RTIL monomer and the poly(diols-RTIL polymer)) with at least one photo-initiator (Para. [0216], Monomer 34 was mixed with photoinitiator (2-hydroxypropiophenone, 2 wt%) using a vortexer...); ii) at least partially coating a support with the mixture of step i) (Para. [0216], ... and poured onto a 250-mm diameter Supor® (100 µm polysulfone) supported material. The monomer on support...); and iii) exposing the coated support of step ii) to UV light to form a photo-initiated polymeric ionic liquid (P-PIL) coated support (Para. [0216], ... placed in a UV oven (UVP Inc., CL-1000 Ultraviolet Crosslinker) and polymerized...supported membranes...).

The inventions listed in Groups I through III therefore lack unity under Rule 13 because they do not share a same or corresponding special technical feature.