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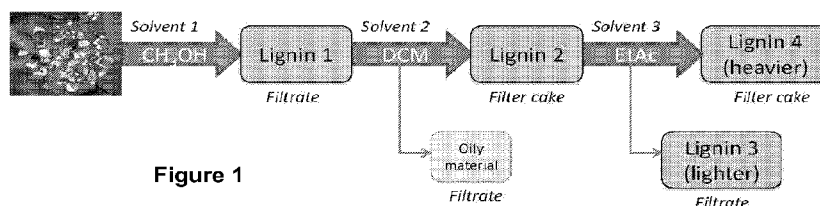


Figure 1

(57) Abstract: Methods for the production and isolation of a monomer from a biopolymer are described. The method includes extracting a biopolymer from a biopolymer source and depolymerizing the biopolymer into a monomer. Methods for the production and isolation of a monomer from corn lignin are also described. The method includes extracting corn lignin from corn biomass and depolymerizing the corn lignin into a monomer.



## INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 14/42263

<b>A. CLASSIFICATION OF SUBJECT MATTER</b> <b>IPC(8) - C07C 1/00 (2014.01)</b> <b>CPC - C10G 3/00; Y02E 50/13; C10L 1/08</b> According to International Patent Classification (IPC) or to both national classification and IPC		
<b>B. FIELDS SEARCHED</b> Minimum documentation searched (classification system followed by classification symbols) USPC- 585/240		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched IPC(8)- C07C 1/00 (2014.01) CPC- C10G 3/00; Y02E 50/13; C10L 1/08; USPC- 585/242		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) PatBase (PGPB, USPT, USOC, EPAB, JPAB, DWPI, TDBD), FreePatentsOnline (US Pat, PgPub, EPO, JPO, WIPO, NPL), GoogleScholar (PL, NPL); search terms: producing monomer biopolymer source depolymerizing biopolymer solvent catalyst coumaric hydroxycinnamic acid		
<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2011/0306804 A1 (Cortright) 15 December 2011 (15.12.2011) abstract, para [0013]-[0017]	1-7, 16-25
X	US 2012/0289692 A1 (Gray et al.) 15 November 2012 (15.11.2012) abstract, para [0010], [0012], [0012]	1-7, 16-25
X	US 2011/0005697 A1 (Shoseyov) 13 January 2011 (13.01.2011) abstract, para [0024], [0026]	1-7, 16-25
X	US 2003/0216326 A1 (Alimi) 20 November 2003 (20.11.2003) abstract, para [0026]	1-7, 16-25
X	WO 2012/151242 A2 (Vermerris et al.) 08 November 2012 (08.11.2012) abstract, abstract, pg 4-5, 24-28	1-7, 16-25
A	Chesson et al. , 'Influence of Plant Phenolic Acids on Growth and Cellulolytic Activity of Rumen Bacteria', applied and environmental microbiology, sept. 1982, p. 597-603.	1-7, 16-25
A	US 3,689,540 A (James et al.) 5 September 1972 (05.09.1972) Abstract, entire document	1-7, 16-25
<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/>		
* 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 08 December 2014 (08.12.2014)		Date of mailing of the international search report <b>16 DEC 2014</b>
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. 571-273-3201		Authorized officer: Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

**INTERNATIONAL SEARCH REPORT**

International application No.

PCT/US 14/42263

**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 Supplemental Box

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.:  
1-7, 16-25

- 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.

## Box No III Observations where unity of invention is lacking

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.

Group I+, claims 1-25 and 51-98, directed to a method for producing a monomer from a biopolymer source. Group I+ will be searched to extent that it reads on a method for producing a monomer from the biomass comprising a nutshell from the candlenut tree, one solvent methanol, without fee. It is believed that claims 1-7, 16-25 read on this restricted invention. Applicants must indicate the claims which read on the first named invention, if different than what was indicated above for this group. Failure to clearly identify how any paid additional invention fees are to be applied to the inventions in "+" group will result in only the restricted invention to be examined. For additional fee(s), an exemplary election would be one divalent metal cation is copper (II), one trivalent metal cation is aluminium (III), reading on claims 1, 8-11 and 15.

Group II, claims 26-50, directed to a method for producing an oligomer.

The groups of inventions listed above 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 (Distinct Technical Features):**

The special technical feature of each invention in Group I+ is a unique method for producing a monomer comprising a unique catalyst and solvent, not required in any other invention in Groups I+.

The special technical feature of Group I+ is a method for producing a monomer from the biomass, not required in Group II

The special technical feature of Group II is a method of producing an oligomer, not required by group I+

**Common Technical Features (Features Do Not Make a Contribution Over the Prior Art):**

Groups I+ and II share the technical feature of a method for producing a product from a biopolymer source, the method comprising depolymerizing at least one biopolymer from the biopolymer source into the product within a system comprised of at least one solvent and at least one catalyst. Inventions of Groups I+ share the technical feature of claim 1.

However, this technical feature is not a unifying technical feature as it does not make a contribution over the prior art as being anticipated by US 2012/0289692 A1 to Gray et al. (hereinafter Gray).

Gray discloses a method for producing a product from a biopolymer source, the method comprising depolymerizing at least one biopolymer (abstract: lignocellulosic; para [0007]: lignocellulosic deconstruction technologies; para [0009]: catalytic biomass deconstruction; para [0012]-[0013], [0044], [0059]; deconstruction = depolymerizing), from the biopolymer source (abstract: lignocellulosic; para [0033]: biomass . . . organic materials produced by plants; para [0012]-[0013], [0044], [0059]), into the product within a system comprised of at least one solvent (abstract, para [0009]- [0013]: solvents used in deconstruction) and at least one catalyst (para [0012]; [0039]), wherein the product is a monomer (para [0010]: hydrolyze the cellulose and hemicellulose to their monomeric components; para [0016]: monosaccharides . . . phenols).

Therefore, Groups I+ and II lack unity under PCT Rule 13.

Note: Phloretic acid is not a monomer that forms lignin polymer in corn. Phloretic acid is produced by hydrogenation of the 2-propenoic side chain of p-coumaric acid. Thus, phloretic acid is a derivative of p-coumaric acid (a hydroxycinnamic acid), which is a monomer that forms polymer in biomass, as evidenced by the article entitled, Influence of Plant Phenolic Acids on Growth and Cellulolytic Activity of Rumen Bacteria, by Chesson et al., APPLIED AND ENVIRONMENTAL MICROBIOLOGY, p. 597-603 (September 1982), see abstract. See also, US 3,689,540 A (James et al.) 5 September 1972 (05.09.1972).