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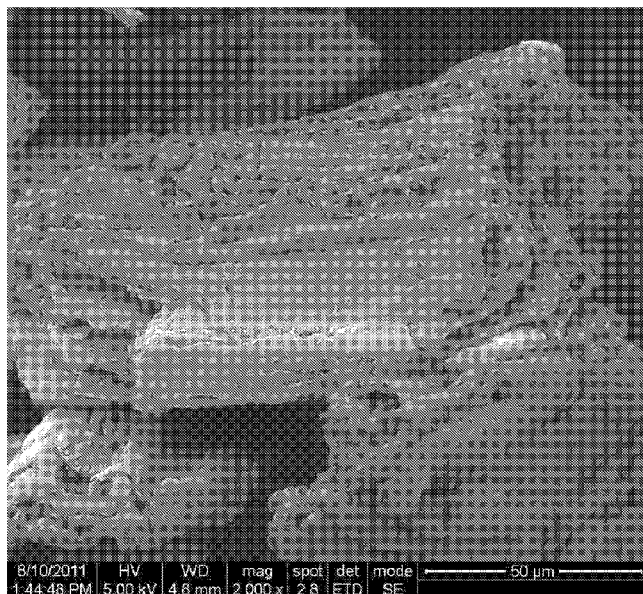
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[Continued on next page]

(54) Title: LIGNIN COMPOSITIONS, METHODS OF PRODUCING THE COMPOSITIONS, METHODS OF USING LIGNIN COMPOSITIONS, AND PRODUCTS PRODUCED THEREBY

Fig. 5



(57) Abstract: Lignin compositions, products produced from them or containing them, methods to produce them, spinning methods, methods to convert lignin to a conversion product and conversion products produced by the methods are described.



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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)*)

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 12/32227

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - B29C 47/00 (2012.01)

USPC - 524/13

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) - B29C 47/00 (2012.01)

USPC - 524/13

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
USPC - 524/31,35,733Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
PubWEST (PGPB,USPT,USOC,EPAB,JPAB) Terms - lignin aqueous phase reforming hydrogenation hydrolysis sulfur sulphur kDa
sulfur-free hydrolyze hydrochloric ash carbohydrate volatiles polyacrylonitrile water fiber water phase solvent de-solvent anti-solvent spin
Google - sulfur-free lignin; high-molecular-weight lignin kDa hydrochloric; purified lig

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4,250,088 A (YANG) 10 February 1981 (10.02.1981), col 2, ln 34-69	1-7, 11(1), 12, 15-16
X	US 2010/0233050 A1 (GARGULAK, ET AL.) 16 September 2010 (16.09.2010), paras [0009], [0040]-[0041]	1, 8(1), 9(1), 10(1)
X — Y	US 5,735,916 A (LUCAS, ET AL.) 07 April 1998 (07.04.1998), col 2, ln 41, col 3, ln 3-25, col 4, ln 34-49, col 6, ln 10-13	1, 14(1), 20(1), 21, 35-36, 38, 43(1), 44-46, 104-111, 114-116 13, 24(1), 25-27, 28(27), 112-113
Y	US 2010/0170504 A1 (ZHANG) 08 July 2010 (08.07.2010), paras [0023]-[0027]	112-113
Y	US 2008/0103344 A1 (JONES, ET AL.) 01 May 2008 (01.05.2008), para [0086]	114, 115(114)
Y	US 6,517,933 B1 (SLOANE, ET AL.) 11 February 2003 (11.02.2003), col 4, ln 8-45, col 10, ln 50-53	13, 24(1), 25-27, 28(27),
A	US 6,284,838 B1 (SILBINGER) 04 September 2001 (04.09.2001), entire document	1-16, 20-21, 24-28, 35-36, 38, 43-46, 104-116
A	US 6,770,168 B1 (STIGSSON) 03 August 2004 (03.08.2004), entire document	1-16, 20-21, 24-28, 35-36, 38, 43-46, 104-116

☐ 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

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 12/32227

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.: 17-19, 22-23, 29-34, 37, 39-42, 47-78, 90-103
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.:
1-16, 20-21, 24-28, 35-36, 38, 43-46, 104-116

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

International application No.

PCT/US 12/32227

Continuation of 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. In order for all inventions to be examined, the appropriate additional examination fees must be paid.

Group I: claims 1-16, 20-21, 24-28, 35-36, 38, 43-46, and 104-116: directed to a lignin composition having a sulfur concentration of less than 0.07% by weight (on a dry matter basis).

Group II: claims 79-89: directed to a process of producing hydrogen from lignin.

The inventions listed as Groups I- II 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:

Group I does not include the inventive concept of a process of manufacturing hydrogen from lignin; as required by Group II.

Group II does not include a lignin composition having a sulfur concentration of less than 0.07% by weight (on a dry matter basis) as required by Group I.

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