



(51) International Patent Classification:

B27N 1/02 (2006.01) B27N 3/04 (2006.01)
B27N 3/00 (2006.01)

(21) International Application Number:

PCT/PH2016/000007

(22) International Filing Date:

22 September 2016 (22.09.2016)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

1-2016-000019 11 January 2016 (11.01.2016) PH

(72) Inventors; and

(71) Applicants : **CHAN, Mark Philip P.** [PH/PH]; Unit 403 Sagada Bldg., Bonifacio Heights Lawton Avenue, Taguig City, 1634 (PH). **CHAN, Gertrude P.** [PH/PH]; 11 Kent St., Filinvest East Homes Mayamot, Antipolo City, 1870 (PH). **CHAN, Katya Danielle Yamzon** [PH/PH]; 20 Carmine St., Brgy. Concepcion 2 SSS Village, Marikina City, 1811 (PH).

(74) Agent: **BULILAN, Neptali L.**; Sapalo Velez Bundang & Bulilan Law Offices, 11th Floor, Security Bank Centre, 6776 Ayala Avenue, Makati City 1200 (PH).

(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, KW, 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).

Declarations under Rule 4.17:

— of inventorship (Rule 4.17(iv))

Published:

— with international search report (Art. 21(3))

— with amended claims and statement (Art. 19(1))

(54) Title: AN ALL NATURAL CELLULOSE FIBERBOARD

(57) Abstract: Disclosed is an environmentally friendly product in the form of an all natural cellulose fiberboard comprising a microbial cellulose fiber, acacia gum as binder and plant cellulose fiber (recycled newspaper). The microbial cellulose fiber is derived from Nata de Coco, a natural polysaccharide composed of ultra- fine highly pure nano-fibrillary network structures at the micro level, and has been shown to possess an impressively high mechanical strength to withstand mechanical forces. The acacia gum is an edible biopolymer exudates from Acacia Senegal which grows in Sudan. It is highly soluble in water with low viscosity and with the right proportion, will result in a more stable and pseudoplastic behavior. Acacia gum is inexpensive and environmentally accepted binder / adhesive emulsifier and can serve as stabilizer and thickener to the product. The plant cellulose fiber, specifically recycled newspaper has been utilized for its insulation and acoustic properties.



AN ALL NATURAL CELLULOSE FIBERBOARD

Description

5 **Technical Field of the Invention**

 This invention relates in general to fiberboards. More particularly, it relates to an all natural cellulose fiberboard produced by blending microbial cellulose fibers and acacia gum with the addition of plant cellulose in the form of recycled newspaper to create a strong green fiberboard.

10

Background of the Invention

 In general, fiberboard refers to engineered wood product that is made out of wood fibers. The known types are particle board, medium-density fiberboard, and hardboard. Fiberboard is sometimes used as a synonym for particle board, but particle board usually refers to low-density fiberboard. Fiberboard, particularly medium-density fiberboard (MDF), is heavily used in the furniture industry. A veneer of wood is often glued onto fiberboard to make it look like a conventional wood.

15

20

 Resins, particularly urea-formaldehyde are dominantly used as binder in the medium density fiberboard (MDF) industry because of their low cost and fast curing characteristics. However, in view of the harmful emissions associated with formaldehyde, another resin known as phenol-formaldehyde (PF) is used.

25

 To eliminate the use of formaldehydes, certain types of fiberboard have been introduced. These are considered "green" building products consisting of bio-based, secondary raw materials (wood chip or sugarcane fibers) and a binding agent consisting of vegetable starch containing no added formaldehydes.

30

 Aside from wood chips or sugarcane fibers, other kind of natural fibers that are being used to make fibreboard are those disclosed in U.S. Pat.

Application No. 10/038,019 filed by Kai Li and Charles Chan, and published as US 2003 0091 804 A1 on May 15, 2003. In the said invention, a fibreboard can be produced using coconut mesocarp fibers. The board can be a medium density fibreboard with resin, a waterproofing composition and firming composition.

5

Another material used are fronds of African oil palm as disclosed in Phil. Pat. No. UM 2/2006/551 issued to Abraham S. Accad et al. In the said utility model, the fibreboard is composed of fronds of African oil palm bonded with water soluble plastic resin glue. The process for producing the fibreboard comprises the following steps:

10

- a) Chopping the dried oil palm fronds;
- b) Dissolving the plastic resin glue in water at 1:1 ratio;
- c) Pouring the dissolved glue on the chopped dried oil palm fronds;
- 15 d) Pouring the mixture on a flat surface, maintaining the $\frac{1}{2}$ of an inch thickness;
- e) Flatten the surface using a rolling pin or any cylindrical object by rolling it over the top in order to produce a smooth surface;
- f) Drying for 6 hours;
- 20 g) Trimming the surface according to desired size of fibreboard.

Still another material used in making fibreboards is the chicken feather fiber disclosed in Philippine Pat. No. 2/2012/358 issued to Hideliza Saipudin et al. In the said utility model, a medium density fibreboard composition comprises a chicken feather fiber, isocyanate resin and Acacia mangium veneer overlay. According to the utility model, chicken feather fibers are very resistant to deterioration, has excellent insulating properties, and can be used as a lightweight termite resistant building material.

30

While the foregoing fiberboards are satisfactory in performance in their intended purpose, still there is a serious need to develop another alternative renewable material for use in the building and construction industry. The present invention aims to provide the said alternative renewable material for use in the

building and construction industry. This alternative renewable material is in the form of a microbial cellulose fibers blended with acacia gum, a natural binder which has no harmful effects to the environment unlike the formaldehyde. A plant cellulose fiber in the form of recycle newspaper may be added or combined in making the fiberboard.

The ideal alternative to carbon rich industrial materials is the use of a microbial cellulose fibers blending it with acacia gum, a natural binder and plant cellulose fiber in the form of recycled newspaper.

The combination of microbial cellulose fibers with acacia gum and recycled newspaper is encouraging and is a unique innovation for material recycling which can be turned into structural overlays / boards and ceilings. The main advantage of using natural fibers is their high energy-absorbing capacity resulting from their low modulus of elasticity. The microbial cellulose fibers have inherent tensile strength because of its ultra-fine highly pure nano-fibrillary network structures.

The high availability of microbial and plant cellulose fibers constitute a good opportunity for the development of sustainable methods for producing eco-friendly panel boards for building materials. Compared to the existing boards reinforced with cement and sand, composites containing microbial cellulose fibers, acacia gum and recycled plant fibers offer a comparable good mechanical properties that does not generate waste residues.

Summary of the Invention

This invention pertains to a cellulose fiber board for use as a green substitute in the construction industry. The cellulose fiber board has a unique composition and proven to have insulation, acoustic and strength properties to serve the construction industry. The extraordinary mechanical properties of the cellulose fiberboard can be explained to the complementing and compatibility and good bonding of the individual components. The microbial cellulose fibers are

characterized by high purity, strength and moldability. In addition, the cellulose fibrils are highly insoluble and inelastic and because of their molecular configuration have a tensile strength comparable to steel.

5 The microbial cellulose fiber is stable to chemicals and at high temperatures. The Young's modulus for microbial cellulose fibers have been reported to be as high as 15 GP'a across the plane of the sheet, whereas the highest Young's attained in the past by polymeric films or sheets is less than 10 GP'a. The very high Young's modulus of this material must be ascribed to its
10 super molecular strength.

 The acacia gum, a natural resin that contains arabin, a sticky semi-fluid from the bark of acacia trees, served as the binder, emulsifier and stabilizer to the microbial cellulose fiber. A study showed that acacia gum satisfies the major
15 physicochemical properties suitable for sand binders in foundry.

 The combined microbial cellulose fibers and acacia gum product exhibit the required strength and serve as the backbone of the invention. Actually, microbial cellulose-acacia gum fiber board can stand alone for industrial
20 application. However, reinforcement with recycled newspaper fibers improved the usefulness of the cellulose board.

 The strengthening of recycled waste fibers (old newspaper) with microbial cellulose fiber in the development of the cellulose fiber board is considered an
25 opportunity for the sustainable management of urban waste. Reduction of carbon footprints in the atmosphere can be achieved. The data taken from Environmental Building News (2005) highlight some of the key environmental impacts of selected insulation types. Results showed that plant cellulose fibers in the form of old newspaper and telephone directories and cottons gave pollution
30 free manufactures; while fiberglass, polyurethane foams and mineral wool gave emissions and high energy use during manufacture. In manufacturing products, the energy is referred to as embodied energy. High embodied energy signifies higher potential negative impact on the environment. Cellulose fiber insulation is

energy efficient compared to fiberglass, with times more embodied energy, and for foam with 60 times more embodied energy. Cellulose then is an efficient energy saver reducing greenhouse gases.

- 5 The present invention has developed an innovative and unique "All Natural Cellulose Fiber Board", a combination of microbial cellulose fiber, acacia gum and recycled newspaper, an ideal candidate for the new generation of construction and industrial materials. The first of its kind.

10 **Detailed Description**

This description is based on a preferred setting divided into the following sections: culture medium ingredients, devices used, processing and drying equipment used for the final product.

15

- Nata de Coco is spun by *Acetobacterxylinum* bacteria by static fermentation. It is produced by culturing these bacteria in coconut milk media. The structure itself is made from a pure cellulose which is biocompatible and used as food delicacies here in our country. The processed nata de coco is non-toxic and non allergenic. There is no industrial hazard in the production of nata de coco.

- 25 The active ingredient used as preservative to prevent decomposition and deterioration of the nata de coco is monolaurin. Monolaurin is derived from coconut oil and prepared into monoester of lauric acid. In 1965 Monolaurin has been placed on the list of GRAS ("generally recognized as safe).

- 30 To produce nata de coco cellulose, the ingredients are the following: sugar, water, acetic acid, mother liquor (*Acetobacterxylinum* bacteria), and coconut milk. Ingredients are mixed and cultured on a plastic tray in a room with a controlled temperature. The allowable temperature for this cellulose to grow is 28°C – 38°C. The yield of product with high cellulose content is very vital for tensile strength of the final product. The cellulose will be harvested on the 7th day

to yield a good quality. This will undergo a cleaning process by removing the white gelatinous base part of the pellicle utilizing a plastic scrapper or splitting machine. The cleaned pellicle will be check for its cellulose consistency, damage, opacity, tear, cellulose contamination and discoloration using a quality control
5 light with white bulb.

The pellicles that passed in the quality control inspection will undergo deacidification process. This process pertains to the washing of cellulose pellicle with water until desired pH 7.4 is attained with the use of a pH meter. The
10 deacidified pellicle will be placed properly in the cutting board by using a pneumatic or mechanical padlock puncher and cutting blade. The size of the coco cellulose is approximately 2-3" x 5". The pre-cut nata de coco will undergo boiling in water for 20 minutes. Then it is set aside to cool environment. Once cooled, the nata de coco will undergo dehydration by placing the nata de coco in
15 the manual pressing machine or conveyor type presser. Manually press the nata de coco pellicles until the water in the pellicle is extracted. Finally, the nata de coco will be cut, punctured and crushed to micro-sized particle -- microbial cellulose fibers.

20 **Processing of the cellulose fiber board**

The initial process is to compound the microbial cellulose fiber with acacia gum using a mechanical mixer for a duration depending upon the volume. The microbial cellulose fiber-acacia gum mixture is placed on a tray, leveled and
25 exposed to an air drying equipment at 70°C until the product is dry. This is followed by mechanical pressing. During the drying process of microbial cellulose fiber, most fibers arrange parallel to each other and form layered sheets adding to high stability and strength because of the formation of more hydrogen bonds among the fibers.

30

The next step is pulping shredded recycled newspaper by soaking in warm water overnight and with enough water blended the next day. The pulp is ligno cellulose fibrous material. The pulp, microbial cellulose fibers and acacia

gum are mixed using the mechanical mixer until you obtain a pasty consistency. This mixture is lined and leveled on top of the dried microbial cellulose fiber-acacia gum composite. This 2 layered composite will also be exposed to an air drying equipment at 70°C until the product is dry. This is followed by mechanical pressing.

The final process is to prepare another microbial cellulose fiber-acacia gum mixture and lined it on top of the pulp-microbial cellulose fiber-acacia gum layer and exposed to an air drying equipment at 70°C until the product is dry followed by mechanical pressing. This is the final product – an all natural cellulose fiberboard. The preferred thickness of the fiberboard is 12 mm to 18 mm and the standard size is 4 x 8 feet. However, the thickness and size of the fiberboard is not limited to the aforementioned dimensions and may vary depending on the requirements of the industry.

15

While specific embodiments have been disclosed, these should not be interpreted as limitations of scope of the subject invention, the true spirit and scope of which being defined by the appended claims.

20

CLAIMS

1. An all natural cellulose fiberboard composition comprising a microbial cellulose fiber bonded with a bonding agent wherein the microbial cellulose fiber is derived from nata de coco.
2. An all natural cellulose fiberboard composition comprising the following components:

a. Microbial cellulose fiber	52-90%
b. Bonding agent	10-48%
3. An all natural cellulose fiberboard composition as in claim 1 wherein the bonding agent is acacia gum.
4. An all natural cellulose fiberboard composition as in claim 1 wherein a plant cellulose fiber is added to the composition and bonded thereto.
5. An all natural cellulose fiberboard composition comprising the following components:

a. Microbial cellulose fiber	40-60%
b. Bonding agent	15-25%
c. Plant cellulose fiber	30-50%
6. An all natural cellulose fiberboard as in claims 4 or 5 wherein the plant cellulose fiber is in the form of a recycled shredded newspaper.
7. An all natural cellulose fiberboard made in accordance with the following process steps:
 - a) Compounding the microbial cellulose fiber with acacia gum using a mechanical mixer for a duration depending upon the volume;

- b) Placing the microbial cellulose fiber-acacia gum mixture on a tray, leveled and exposed to an air drying equipment at 70°C until the product is dry.
- 5 c) Mechanically pressing the composition whereby during the drying process of microbial cellulose fiber, most fibers arrange parallel to each other and form layered sheets adding to high stability and strength because of the formation of more hydrogen bonds among the fibers;
- 10 d) Pulping shredded recycled newspaper by soaking in warm water overnight and with enough water blended the next day wherein the pulp is ligno cellulose fibrous material.
- e) Mixing the pulp, microbial cellulose fibers and acacia gum using the mechanical mixer until a pasty consistency is obtained.
- 15 f) Lining and leveling up the mixture on top of the dried microbial cellulose fiber-acacia gum composite whereby the 2 layered composite is exposed to an air drying equipment at 70°C until the product is dry;
- g) Subjecting the composite to mechanical pressing;
- 20 h) Preparing another microbial cellulose fiber-acacia gum mixture and lining it up on top of the pulp-microbial cellulose fiber-acacia gum layer;
- i) Exposing the composite to an air drying equipment at 70 degrees Centigrade until the product is dry;
- j) Subjecting the composite to mechanical pressing.

25

received by the International Bureau on 05 May 2017 (05.05.17)

CLAIMS

1. An all natural cellulose fiberboard comprising a composition which comprises a microbial cellulose fiber bonded with an acacia gum bonding agent wherein the microbial cellulose fiber is derived from nata de coco.
2. An all natural cellulose fiberboard as in claim 1 comprising a composition which comprises the following components:
- | | |
|--|--------|
| a. Microbial cellulose fiber derived from nata de coco | 52-90% |
| b. Acacia gum bonding agent | 10-48% |
3. An all natural cellulose fiberboard as in claim 1 wherein a plant cellulose fiber is added to the composition of the microbial cellulose fiber derived from nata de coco and acacia gum bonding agent and bonded thereto.
4. An all natural cellulose fiberboard as in claim 1 comprising a composition which comprises the following components:
- | | |
|--|--------|
| a. Microbial cellulose fiber derived from nata de coco | 40-60% |
| b. Acacia gum bonding agent | 15-25% |
| c. Plant cellulose fiber | 30-50% |
5. An all natural cellulose fiberboard as in claims 3 or 4 wherein the plant cellulose fiber is in the form of a recycled shredded newspaper.
6. A process of manufacturing an all natural cellulose fiberboard as in claim 1 comprising the following process steps:
- | | |
|--|--|
| a. Compounding the microbial cellulose fiber derived from nata de coco with acacia gum using a mechanical mixer for a duration depending upon the volume; | |
| b. Placing the microbial cellulose fiber-acacia gum mixture on a tray, leveled and exposed to an air drying equipment at 70°C until the product is dry; | |
| c. Mechanically pressing the composition whereby during the drying process of microbial cellulose fiber, most fibers arrange parallel to each other and form layered sheets adding to high stability and | |

strength because of the formation of more hydrogen bonds among the fibers;

- 5 d. Pulping shredded recycled newspaper by soaking in warm water overnight and with enough water blended the next day wherein the pulp is ligno cellulose fibrous material;
- e. Mixing the pulp, microbial cellulose fibers and acacia gum using the mechanical mixer until a pasty consistency is obtained;
- 10 f. Lining and leveling up the mixture on top of the dried microbial cellulose fiber-acacia gum composite whereby the 2 layered composite is exposed to an air drying equipment at 70°C until the product is dry;
- g. Subjecting the composite to mechanical pressing;
- h. Preparing another microbial cellulose fiber-acacia gum mixture and lining it up on top of the pulp-microbial cellulose fiber-acacia gum layer;
- 15 i. Exposing the composite to an air drying equipment at 70 degrees Centigrade until the product is dry; and
- j. Subjecting the composite to mechanical pressing.

STATEMENT UNDER ARTICLE 19(1)

Reference: International Search Report mailed on 21 March 2017 (21-03-2017) in respect of PCT/PH2016/000007 with international filing date of 22 September 2016 (22-09-2016)

1. Amendments to claims 1-2 and 4-5 wherein an all natural cellulose fiberboard is claimed instead of merely a composition, and specify that the microbial cellulose fiber is derived from nata de coco and the bonding agent is acacia gum, define the invention with clarity and make the subject-matter of claims 1-2 and 4-5 novel and inventive over cited references D1 and D2. Further, the subject-matter of amended claim 1 is now supported by the description and solves the problem underlying the invention.
2. The amendment to claim 7 as a process claim of manufacturing the fiberboard of claim 1 renders claim 7 clear, novel and inventive over the available prior art since manufacturing of a novel and inventive product (cellulose fiberboard of claim 1) represents a novel and inventive method claim.

International application No
PCT/PH2016/000007

INV. B27N1/02 B27N3/00 B27N3/04
ADD.

Minimum documentation searched (classification system followed by classification symbols)
B27N

EP0-Internal, WPI Data

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2005 060680 A (UNIV KYOTO; ROHM CO LTD; MITSUBISHI CHEM CORP; HITACHI LTD; PIONEER EL) 10 March 2005 (2005-03-10)	1
Y	paragraphs [0003], [0012], [0021],	2-6
A	[0038] - [0041], [0045] - [0050], [0052], [0053], [0058], [0061], [0074], [0075], [0110], [0111], [0114] paragraphs [0117], [0118], [0129], [0130] examples 5,8 claims 1,2,4,15,20,22 ----- -/--	7

X See patent family annex.

"&" document member of the same patent family

Baran, Norbert

INTERNATIONAL SEARCH REPORT

International application No
PCT/PH2016/000007

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 1 469 126 A1 (KANSAI TECH LICENSING ORG CO [JP]) 20 October 2004 (2004-10-20)	2
Y	paragraphs [0006], [0011], [0014], [0015], [0018], [0019], [0022] - [0024], [0026], [0039], [0040], [0050], [0063] claim 1	2,4-6
Y	----- WO 2015/099083 A1 (NISSAN CHEMICAL IND LTD [JP]) 2 July 2015 (2015-07-02) examples 5,6 & EP 3 088 008 A1 (NISSAN CHEMICAL IND LTD [JP]) 2 November 2016 (2016-11-02) paragraphs [0039], [0040], [0043], [0058] examples 5,6	3
X	----- ÖZGÜR SEYDİBEYOĞLU M ET AL: "Green polyurethane nanocomposites from soy polyol and bacterial cellulose", JOURNAL OF MATERIALS SCIENCE, KLUWER ACADEMIC PUBLISHERS, BO, vol. 48, no. 5, 4 December 2012 (2012-12-04), pages 2167-2175, XP035155094, ISSN: 1573-4803, DOI: 10.1007/S10853-012-6992-Z abstract paragraphs [Introduction], [Experimental] figures 1,5 page 2170, column 2, line 21 - column 2, line 25 page 2174, column 1, line 7 - column 1, line 20	1
A	----- Anonymous: "Nata de coco - Wikipedia, the free encyclopedia", 5 November 2015 (2015-11-05), pages 1-2, XP055352536, Retrieved from the Internet: URL:http://web.archive.org/web/20151105121602/http://en.wikipedia.org/wiki/Nata_de_coco [retrieved on 2017-03-08] page 1 ----- -/--	1

INTERNATIONAL SEARCH REPORT

International application No

PCT/PH2016/000007

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	Anonymous: "Microbial cellulose - Wikipedia, the free encyclopedia", 23 November 2015 (2015-11-23), pages 1-3, XP055352541, Retrieved from the Internet: URL:http://web.archive.org/web/20151123115228/https://en.wikipedia.org/wiki/Microbial_cellulose [retrieved on 2017-03-08] pages 1,2	1,2,5,7
A	----- Anonymous: "Bacterial cellulose - Wikipedia, the free encyclopedia", 27 October 2015 (2015-10-27), XP055352681, Retrieved from the Internet: URL:http://web.archive.org/web/20151027100529/https://en.wikipedia.org/wiki/Bacterial_cellulose [retrieved on 2017-03-08] page 1 - page 6 -----	1,2,5,7

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/PH2016/000007

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 2005060680 A	10-03-2005	JP 4724814 B2	13-07-2011
		JP 2005060680 A	10-03-2005

EP 1469126 A1	20-10-2004	AT 386841 T	15-03-2008
		AU 2002367112 A1	15-07-2003
		CA 2470905 A1	10-07-2003
		DE 60225186 T2	12-02-2009
		EP 1469126 A1	20-10-2004
		JP 3641690 B2	27-04-2005
		JP 2003201695 A	18-07-2003
		US 2005067730 A1	31-03-2005
		WO 03056103 A1	10-07-2003

WO 2015099083 A1	02-07-2015	EP 3088008 A1	02-11-2016
		TW 201538163 A	16-10-2015
		US 2016325011 A1	10-11-2016
		WO 2015099083 A1	02-07-2015
