(54) Title: NOVEL MATERIAL FROM COCONUT SHELL AND MANUFACTURE THEREOF

(57) Abstract: The invention provides a novel material that can be used as substitute for tiling and decorating materials. In details it is a composite material incorporating the hard shell of coconut and binders, wherein the coconut shell exists in the form of numerous pieces bound together by binders. In addition to advantageous properties such as strength, resistance to abrasion, natural and unique patterns, the product according to the present invention can be easily used together with almost all other construction materials. Particularly, it has the capability of withholding odors. The invention also provides a process for manufacturing tiling bricks from coconut shell that improves the value thereof and more importantly, contributes the decrease the demand as well as exploitation of limited resources such as precious wood and granite, etc.
NOVEL MATERIAL FROM COCONUT SHELL
AND MANUFACTURE THEREOF

Field of the invention

The present invention relates to a novel material used for tiling and the manufacturing method thereof. In more details, it relates to a tiling material of high durability that is manufactured from coconut shell in combination with polymers and filling materials in which shaped pieces of coconut shell are bound together by means of polymeric adhesives and are consolidated by filling materials.

Background arts

By far a major part of coconut shell, i.e. the hard shell of coconut, is a by-product of low quality that is used as a cheap fuel so as to reduce the discharging expense. Recently a minor part of coconut shell is used for manufacturing handicraft products and another minor part for making activated carbon. Nevertheless, the volume used is inconsiderable when compared with the quantity of coconuts, the copra therefrom have long been used for production of coconut oil. Another factor that limits such use is the expensiveness of technology and equipment for making activated carbon.

Another solution is to make full use of coconut shell by converting it into construction materials.

Australia Patent 7,967,700 describes a novel material manufactured by heating coconut shell in a rotary kiln over 1800°C, mixing the resultant activated carbon with a natural adhesive, and cold pressing and drying, then forming boards. The material does not emit noxious gases, is effective in soundproofing, heat insulation, and maintaining the indoor environment comfortable. Nevertheless, this material does not keep the natural form of coconut shell and furthermore, the manufacturing process thereof is complicated.

Another well-known prior art are manufacturing of plywood with crushed natural materials such as sawdust and the like mixing with adhesives and being pressed to make planks. This solution is obviously not feasible for coconut shell for its high hardness and consequently, the crushing expense is high.
That is realized as described in Australia Patent 3,825,499 (WO 9956923), wherein coconut shell is pulverized, mixed with adhesive, extruded then the adhesive is activated by pressing to the end-form of the product. That solution keeps up the natural characteristics of coconut shell yet alike the plywood solution, the expense on pulverizing is very high.

It is therefore an object of the present invention to provide a novel material from coconut shell meeting various demands for construction and indoor decoration and particularly having the ability of withholding odors.

Another object of the present invention is a simple manufacturing process for manufacturing the novel material from coconut shell.

**Disclosure of the invention**

In order to accomplish the above objects, the present invention associates the advantageous properties of coconut shell with epoxy binders and creatively employs the simple machines and equipment for the combination, wherein the coconut shells exist in the form of naturally cracked pieces. Hereinafter the exemplary illustrations of the present invention are described in details, but by no means limited by the following illustration.

**Brief description of the drawings**

Fig. 1 is a diagram showing the structure of the novel material according to an embodiment of the present invention;

Fig. 2 is a diagram showing the combination structure according to another embodiment of the present invention; and

Fig. 3 is a process diagram of the exemplary illustration of manufacture according to the present invention.

**Best modes for carrying out the invention**

According to Fig. 1, the novel material according to the present invention has an upper layer being pieces of coconut shell 1 joining together by means of joints 2. As such, the material is seen as coconut shell pieces 1 together with interstices 2. Thanks to the natural hardness of coconut shell, the novel material according to the present invention has at the same time the normal properties of natural wood such as
strength, heat insulation, soundproofing and advantageous characteristics of coconut shell such as odor-withholding.

In general, the strength of the novel material according to the present invention is partly dependent upon the adhesiveness of the used binder. Nevertheless, since coconut shell has the cellulose keratinous structure with numerous microscopic capillaries and pores, the binder can easily enter deeply inside and create sound adhesion. Therefore, it is possible to employ various kinds of binder for manufacturing the novel material according to the present invention.

In a preferred embodiment, epoxy binder is employed. There are many kinds of epoxy binder that meet the requirements of adhesion, stability, durability yet the more financially efficient and highly available one is Binder AB, which stands for the AB epoxy with the triethylamine as coagulant. As shown in Fig. 1, the binder is not only present at interstices 2 but also enters deeply to pores and capillaries of coconut shell pieces 1, thereby the binder enhances the hardness of not only joints 2 but also the durability of coconut shell pieces 1.

Another advantageous property of the material according to the present invention is that the natural surface and color of coconut shell pieces remain unchanged and the joints 2 create natural patterns on the material surface. Therefore, the novel material according to the present invention can be used as substitute wood.

Also because of the unchanged coconut shell structure, binders can enter easily to pieces 1 that allows binding the novel material according to the present invention with other materials such as wood, plywood, concrete, etc., meaning that the novel material provide easy use together with other kinds of construction materials. Furthermore, when pieces 1 are made congruent, the patterns of the coconut shell in combination with the patterns of pieces 1 and joints 2 open an indefinite capability for decorating the products made of other materials.

In order to improve the hardness, in another preferred embodiment, fillers, preferably stone powder, are mixed with the epoxy binder. After coagulation, the epoxy binder combining with the filler forms the bone structure of the block or board of the novel material. That structure gives the material according to the present invention a preeminent strength when compared with any kinds of known wood.
Another preeminent characteristic of the novel material according to the present invention is that the presence of fillers, preferably stone powder, causes no impact on the natural nature as well as aesthetic features of the material.

From the joined pieces as illustrated in Fig. 1 it is possible to join two or more layers as illustrated in Fig. 2 in order to improve the hardness of the material and to fabricate boards of larger dimensions. It is furthermore possible to arrange boards of the novel material such that the bone structures of adjacent layers are not coincided. Nevertheless, in practice the combination of a ply of the material according to the present invention and a ply of ordinary wood can provide a board of preeminent properties.

Since coconut shell has numerous pores and capillaries, in another embodiment, the novel material according to the present invention is coated with a damp-proof material, preferably polymers, more preferably polyurethane. Thanks to the spongy structure of coconut shell, the damp-proof material can easily enter deep inside, forming a steady coat on the targeted surface of the material.

In another preferred embodiment, the material according to the invention is glossed with a layer of another material, preferably polyurethane and/or nitrocellulose. In practice, the board of the novel material according to the invention is first adhered on the surface in need of decoration, and then the gloss material is coated as a finishing step.

In the context of more scarcity of hard and precious wood, higher demand for forest protection and more stringent regulations on environmental protection, the novel material according to the present invention has a significant role to play in environmental protection as it is made from a waste by-product of coconut. Compared with other tiling boards made from rubber wood and the like, the novel material according to the invention has other preeminent characteristics such as higher durability, and resistance to wood eaters though it is not chemically treated.

As such, the novel material according to the present invention advantageously makes full use of the hard shell of coconut as for substitution of wood. And that makes a significant contribution to limiting deforestation and environmental deterioration at the time being.
Another preeminence of the novel material according to the present invention, as tested with results shown in Table 1, is the capability of substitution of natural flooring materials such as granite and the like, which are expensive and possibly running out.

<table>
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<tr>
<th>No.</th>
<th>Parameters</th>
<th>Unit</th>
<th>Plywood</th>
<th>Granite (according to Vietnamese Standard TCVN 6883:2001)</th>
<th>Material according to the present invention</th>
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<tr>
<td>1</td>
<td>Moisture saturation</td>
<td>% N/mm²</td>
<td>6.8</td>
<td>0.5</td>
<td>17.6</td>
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<td>2</td>
<td>Bending strength</td>
<td>N/mm²</td>
<td>2.39</td>
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<td>3</td>
<td>Surface hardness on the Mohr’s scale</td>
<td>-</td>
<td>7</td>
<td>2-3</td>
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<tr>
<td>4</td>
<td>Thermal elasticity index</td>
<td>10⁶.K⁻¹</td>
<td>9</td>
<td></td>
<td>11.6</td>
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As shown in Table 1 with some parameters, the novel material according to the present invention has the surface hardness and thermal elasticity compatible with that of granite that means much better than the ordinary wood of high quality.

The material according to the present invention has also the durability equivalent to other kinds of wood of prime quality. At the same time, it has high capacity of adsorbing moisture, providing end-products with a permanent cool surface.

Besides, since the novel material is resistant to wood eaters though it is not treated with chemicals, and particularly the unique property of withholding odors thanks to the surface-processing technology according to the present invention, it is preeminent over other artificial materials in term of safety for users with no emission of toxic or offensive gases when it is newly put into use.

In experiments for evaluating the capability of withholding odors, the novel material according to the invention withheld the odor of kola for a number of days.

The binding of small pieces of various shapes is a barrier to the productions of new materials by binding. And another advantageous feature to the manufacturing process according to another aspect of the present invention is a process that helps bind coconut shell pieces in a simple and speedy manner.
As illustrated in Fig., the process for manufacturing the novel material according to the present invention consists of:

- preliminary treatment,
- cutting into curved pieces of predetermined sizes and shapes,
- flattering and at the same time cracking the curved pieces,
- binding and forming the cracked pieces,
- sharpening the edges of the formed pieces,
- polishing the surface, and
- surface processing.

In details, after the removal of copra (for extraction and production of coconut oil) and coconut fiber (for production of coconut thread and the like), the remained coconut shell has the form of two hemispheres. In the preliminary treatment, the remainder of copra is removed by polishing machines known per se then coconut shell is dried until it has stable moisture, normally about 12%.

The two-layer part of coconut shell is then cut off and the remainder is cut into curved pieces with preset sizes and shapes such as squares, triangles, waving rectangles, etc. by means of mounting systems and sawing machines well known in the art.

Thereafter, the curved pieces are put into battering machines, in which they are flattened. On flattering, the curved pieces break into many smaller pieces and at the same time they are cracked along random fissures. It is possible to fix the smaller pieces so as to ease the binding thereof with methods known in the art. However, the inventor of the present invention discovered a simple and easy way of fixing the broken and cracked pieces that is to apply an adhesive film, preferably adhesive tape on the curved pieces. After passing the battering machines, the broken pieces are still fixed on the adhesive tape and therefore easy to undergo the subsequent steps.

Because the curved pieces (broken) are fixed as mentioned above, they are easily subject to edge-sharpening on sharpening machines well known in the art.

In the subsequent step, a binder, that is the mixture of epoxy and a filler, preferably stone powder, is applied to the fissures of pieces then the pieces are bound together forming crude products in the form of relatively flat pieces. Many kinds of
epoxy binder meet the requirements for production. In an embodiment of the present invention, the binder is a binder commonly used in wood processing and known as "AB epoxy" or the trademark of "Hai Thuyen".

In order to obtain perfect flatness, the relatively flat pieces are polished with polishing machines well known in the art.

Thereupon, the flat pieces undergo surface treatment, turning into products.

The products have the same shapes and sizes which can be varied in accordance with the end uses. Obviously, the surface treatment can be carried out either shortly after the flat pieces are formed or after tiling or binding them on the surfaces of end-use subjects.

In another embodiment, the surface treatment is to apply damp-proof to the surface of the material, thereupon the products become water-proof. Thanks to the hardness of coconut shell pieces and the strong binding therebetween, the products can substitute granite for flooring.

In another embodiment, the surface is coated with a gloss layer. It is possible to apply the gloss layer to the damp-proof layer and water-proofing is assured whilst the glossiness of the products is improved.

In a preferred embodiment, after the steps of polishing, damp-proof coating, and drying, the boards of the novel material according to the present invention have the surface layer removed by means of polishing machines known per se. Since the damp-proof material enter deeply inside to numerous capillaries and pores of coconut shell pieces, such polishing removes only a part of the damp-proof material, hence the novel material according to the present invention still has a certain water-proofing capability and at the same time, good properties of coconut shell such as withholding of odors and adsorbing gases, etc.

Besides, the material can be used for making family-use aids such as saucers, handles of knives, folks, scoops or spices trays, etc.

Particularly, the novel material can be used as glaze-substitute in china clay production or as Formica in coating and decorating other products.
Preliminary treatment

Cutting

Battering

Binding

Sharpening

Polishing

Surface treatment

H. 3
CLAIMS

1. A material composing of at least one layer being pieces of coconut shell that are flattened, shaped and bound edge by edge by a binder.

2. The material as claimed in claim 1, wherein the binder is epoxy adhesive.

3. The material as claimed in claim 1 or claim 2, wherein the binder is epoxy admixed with filler.

4. The material as claimed in claim 3, wherein the filler is selected from the group consisting of stone powder and the similar materials thereof.

5. The material wherein two layers of the material as claimed in any claim from 1 to 4 are bound together.

6. The material as claimed in any claim from 1 to 5 wherein it is coated with a damp-proof material.

7. The material as claimed in any claim from 1 to 6 wherein it is coated with a gloss material.

8. A process for manufacturing the material as claimed in any claim from 1 to 7, composing of

   preliminary treatment,
   cutting coconut shells into curved pieces of predetermined sizes and shapes,
   battering for breaking and cracking the curved pieces,
   binding,
   sharpening edges,
   polishing surfaces, and
   surface treatment.

9. The process as claimed in claim 8, wherein the surface treatment composes of applying a damp-proof material to the surfaces.

10. The process as claimed in claim 8, wherein the surface treatment composes of applying a gloss material to the surfaces.

11. The process as claimed in claim 8, wherein the surface treatment composes of applying a damp-proof material and a gloss material to the surfaces.
12. The process as claimed in any claim from 8 to 11, wherein the surface treatment further composes of polishing away part of the damp-proof material.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
   IPC7 B27N 3/02, IPC7 B27N 3/00, IPC7 B29C 70/06

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)
   IPC7 B27N 3/02, IPC7 B27N 3/00, IPC7 B29C 70/06

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
   KOREAN PATENTS AND APPLICATIONS FOR INVENTIONS SINCE 1975
   JAPANESE UTILITY AND APPLICATIONS FOR INVENTIONS SINCE 1975

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<tr>
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<td>X</td>
<td>JP 05-069422 A (MITSUBISHI MATERIALS CORP), 23 MARCH 1993/(23.03.1993) SEE ABSTRACT AND CLAIMS</td>
<td>1,4,5</td>
</tr>
<tr>
<td>Y</td>
<td>JP 09-094887 A (AKYAMA SHOJI), 08 APRIL 1997/(08.04.1997) SEE THE WHOLE DOCUMENT</td>
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  "A" document defining the general state of the art which is not considered to be of particular relevance
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"T" Inter 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

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"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

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   09 MARCH 2004 (09.03.2004)

Date of mailing of the international search report
   10 MARCH 2004 (10.03.2004)

Name and mailing address of the ISA/KR
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   KIM, Jang Gang

Telephone No. 82-42-481-5544

Form PCT/ISA/210 (second sheet) (January 2004)
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