METHOD OF MANUFACTURING A STIFF ENGINEERED COMPOSITE

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The method of making a compressed biocomposite body includes compressing a mass of biocomposite material comprised of discrete particles and a network of interconnected glucan-containing mycelia cells in the presence of heat and moisture into a compressed body having a density in excess of 18 pcf. Compression may take place batch wise in a press or continuously in a path of narrowing cross-section defined by a series of heated rollers.
Step 1
Porous Inoculum - Particle Fibers - Trace Nutrients - Water

Step 2
Mix substrate components and inoculum volumetrically or gravimetrically.

Step 3
Place growth media in a rolled enclosure, a flat enclosure, or series of enclosures.

Step 4
Mycelia is grown matching the geometry of the enclosure.

Step 5
Mycelia is ground, and placed in a new enclosure to complete growth.

Step 6
Mycelia and particle and/or fibers are intermixed.

Step 5a
Mycelia colonized particles and/or fibers are pressed in a heated plate press.
METHOD OF MANUFACTURING A STIFF ENGINEERED COMPOSITE


[0002] This invention relates to a method of manufacturing a stiff engineered composite. More particularly, this invention relates to a method of producing stiff mycelium bound parts.

[0003] As is known, conventional methods for producing nonstructural boards rely on compressing wood veneer sheets, fibers, or particles and binding them together with resin to form composites like hardboard plywood and medium density fiberboard, which are used for applications such as furniture and fixtures, cabinetry, paneling, molding and athletic equipment. The ingredients for these typical non-structural boards require considerable pre-processing, and the feedstocks, especially timber and resins, are subject to considerable price volatility. Additionally, many of the resins used to produce non-structural boards are carcinogenic and can emit volatile organic compounds (VOCs).

[0004] Much like nonstructural boards, structural boards are produced by compressing wood veneer sheets, fibers, or particles and binding them together with resin to form composites like oriented strand board (OSB) and softwood plywood. OSB and softwood plywood are used for applications such as wall sheathing, floor sheathing, and concrete framework. These structural boards face the same concerns that nonstructural boards face because they use similar feedstocks and resins.

[0005] Many structural and nonstructural boards are used for applications in furniture, cabinetry, and fixtures where they must be cut, milled, and sanded to form the desired shape. Such post processing is expensive and time consuming and creates material waste if the products are shaped. Plastics are also used for these applications and require expensive tools and machines for molding in their production processes.

[0006] US Published Patent Application 2008/0145577 describes various techniques for making self-supporting composite bodies comprised of discrete particles and a network of interconnected mycelium cells bonding the particles together. As described therein, the composite bodies may be formed into panels as well as into panel systems with a composite core.

[0007] It is an object of this invention to provide an improved process for the manufacture of a compressed composite body of particle/mycelium.

[0008] Briefly, the invention provides a method of achieving adhesion between a matrix of fungal mycelium and a slurry of particles and/or fibers (natural or synthetic) through a heated compression process.

[0009] US Published Patent Application 2008/0145577 has demonstrated that fungal mycelium can bind natural (ligno-cellulosic and chitinous waste streams) and/or synthetic (fiberglass) particles together during a controlled incubation process. The mycelium in the latter instance serves as a grown adhesive, digesting a portion of the particles and fibers while encapsulating the slurry in a network of a vegetative tissue.

[0010] The process described within demonstrates that the extracellular matrix of mycelium, known as the matrix layer of the cell wall and comprised of polysaccharides (alpha and beta glucans), polymerized amino sugars (N-glucosamine, chitin), monoprotons, and phospholipids, can serve as a traditional adhesive when heated and dried concurrently. The mycelium is either grown on, or mixed with, an engineered substrate of natural and/or synthetic particles and/or fibers and then compressed under heat and dried to desired geometry.

[0011] The heating of the mycelium matrix actually provides value in two places, which makes this process distinctly different from the prior art. The fungal cell wall is comprised of chitin and glucans. The glucans, when heated and saturated with the moisture embedded within the composite, begin to flow like a traditional resin and when dried stick the particles together beyond the traditional mycelium matrix.

[0012] By creating sheets of material made from particles bound together with mycelium (hereinafter “the biocomposite material”) and compressing these sheets together, bio-based nonstructural boards can be created with feedstocks. The sheets of biocomposite material can be grown together or compressed together with heat to set and dry the final product. The sheets of biocomposite material can vary in product density, fiber content, particle size, and fiber orientation to selectively promote specific mechanical properties (screw hold strength, core shear, modulus of elasticity).

[0013] Further, a large mass of mycelium can be cultivated on particles or fibers, milled to a consistent particle size and then pressed in a constrained heated tool.

[0014] Additionally, VOCs are not a concern for structural boards produced in this manner because no VOC emitting resins are used in the production process, and the cross-linking occurs between the biochemical construct of the fungal cell wall.

[0015] There are significant mechanical advantages garnered from compressing sheets of mycelium bound particles into a single cohesive product with heightened temperatures (200° F.-650° F.) while compressing the biocomposite material at a pressure of from 10 to 1500 psi. These advantages include enhanced modulus of rupture and elasticity (stiffness), and the ability to layer sheets of varying particles size to achieve greater stiffness or dimensional stability (squareness, flatness).

[0016] Other materials, including veneers, textiles, or laminates, that are comprised of wood, plastics (polyester scrim), foam, natural fibers, stone, metal, or the like can be grown and bound to the face or internal structure of the mycelium and particle sheets. These laminates can be stacked and interlaid to the mycelium colonized particle sheets, and then compressed to a desired form (flat or molded).

[0017] Structural boards can be created by compressing thick blocks of grown material or layered sheets of grown material (particles and/or fibers bound by mycelium) while drying with heat (radiation, conduction, or convective).

[0018] Orienting particles within an engineered substrate and then preliminarily binding these with mycelium creates a bio-based product that does not emit VOCs.

[0019] The compressed biocomposite material can be easily and cheaply shaped during production. The grown material can be compressed in an inexpensive mold (fiberglass, carbon fiber, composite, wooden and/or metal, e.g. aluminum), giving the material the desired shape and material properties without creating waste. The final product can be dried in the tool to promote cross-linking between the natural polymers within the mycelium, which can occur within the magnitude of minutes.

[0020] The grown material can also be compressed in a conductive tool that is heated as well to the final shape, either with a heated platen or inserted cartridges.
These and other objects and advantages of the invention will become more apparent from the following detailed description taken in conjunction with the accompanying drawings wherein:

FIG. 1 schematically illustrates the steps in the method of manufacturing a stiff engineered composite in accordance with the invention.

Referring to FIG. 1, in accordance with the method of the invention, an engineered substrate bound with mycelium 10 is grown into a sheet of appropriate dimensions in step 1. In this respect, the basic steps of the method include:

1. Obtain substrate constituents, including fungal inoculum, a bulking collection of particles and/or fibers, a nutrient source or variety of nutrient sources, and water.

2. Combine the substrate constituents by mixing together in volumetric or mass ratios to obtain a solid media with the inoculum (cell and/or tissue culture) added during or following the mixing process.

3. Place the growth media in an enclosure or series of enclosures of the desired geometry.

4. Allow the mycelia to grow through the substrate, creating a composite with a geometry matching the enclosure. This may be either the final geometry or the net geometry of the final product.

For parts that are dried in compression, the mycelium does not have to grow on the engineered substrate but could be grown in a secondary process and thoroughly intermixed to distribute culture just prior to compressive drying (conduction, convection, radiation).

Repeat steps 1-3 for applications where materials are layered or embedded to create the desired final composite media. Alternatively to steps 3 and 4, the growth media may be grown as a solid mass, and then ground up for later steps or placed in an enclosure of the desired shape and then be allowed to regrow into that shape.

5. Repeat steps 1-3 for applications where the materials are grown and colonized, and then alternative to steps 3 and 4, the growth media is milled or particulated into the uniform size. The resultant particles are then compressed into a constrained and heated tool.

In step 2 of the method, the engineered substrate 10 containing some residual moisture and, for example in the form of a flat rectangular plate or tile, is placed in a compression fixture 11, for example, a pinch press 11. As illustrated, the pinch press 11 has a bottom platen 12 that can be heated and that is formed with a mold body 13 of predetermined shape, for example, of semi-cylindrical shape. The pinch press 11 also has a top platen 14 for engaging on the bottom platen 12 with a cavity 15 within the platen 14 for mating about the mold body 13. Typically, when the platens 12, 14 are closed together, a semi-cylindrical gap exists between the mold body 13 and the cavity 15.

Typically the engineered substrate 10 should contain a minimum of 10% moisture by weight. Steam may also be injected a dry mass during compression to induce the adhesion.

Since the glucans are activated by set by steam, the engineered substrate 10 should contain a minimum of 40% moisture by weight so that the moisture may be transformed into steam during the heated pressing process as otherwise live steam would be injected into the dry mass during compression to induce the adhesion.

After positioning of the engineered substrate 10 on the mold body 13 of the pinch press 11, the top platen 14 is lowered onto the bottom platen 12 in order to compress, trim and dry the biocomposite material of the substrate 10.

During operation, the pinch press 11 is heated to 300°F while compressing the biocomposite material of the substrate to between 10 psi and 1500 psi. The length of time that the biocomposite material of the substrate 10 is retained within the pinch press 11 under heat and pressure is sufficient to the reduce the moisture content of the material to less than 10% by weight and to promote cross-linking between the natural polymers within the mycelium. The biocomposite material can also be held in the pinch press 11 for a time sufficient to achieve a product stiffness that is sufficient to remove the compressed material from the pinch press 11 ("tool" or "back").

In step 3 of the method, with the pinch press 11 opened, a compressed monolithic body 16 is removed from the pinch press 11. As illustrated, the monolithic body 16 has a semi-cylindrical shape and is characterized as being a rigid shell.

Variations

Additional methods can also be used to produce desirable properties in the final composite.

The substrate of engineered particles and/or fibers ("biocomposite material"), either colonized with mycelium (biotic) or intermixed with mycelium (inactive), can also include cation salts (divalent Na2+, and the like) that can assist with cross-linking between the polysaccharides and amino sugars. Acids (hydrochloric, acetic, lactic) can be provided as well to ensure the substrate stays protonated.

The cations can be applied in a solution by either vacuum infusing the solution into the substrate or immersing the substrate in a cation solution for a certain period of time.

Surface treatments, such as laminates, veneers, or supplemental fibers, can be bound to the engineered substrate. For example, a laminate can be placed on the face of the engineered substrate during the initial growth step. This is "colonization". Alternatively, a laminate may be applied to the engineered substrate just before pressing and bound with only the glucans.

The laminate treatments are applied to the surfaces, or in between tiles if monolayer sheets are used, and pressed with a heated platen until the biocomposite material is <10% moisture.

Laminations and inserts can also be pressed into the surface of a colonized engineered substrate, again using the adhesion from the glucans. The laminations can include non-woven textiles, woven products (jute, fiberglass), and Kraft paper, which become an integrated component of the final part.

Inserts can be positioned either the lower or upper platens of the compression tooling, and can be pressed into the biological composite during the setting process.

The biocomposite material can also be dried to a particular moisture content with conduction, convection, and/or radiation at atmospheric pressure, and then compression dried to complete the process.

The biocomposite material can be treated to a moisture content of between 6% and 30% during the heated compression stage to retain enough moisture to impart electrical
conductivity such that the resultant compressed monolithic body can be powder coated since a powder coating process requires the material to be electrically conductive and moisture, rather than metals salts, is used to impart this characteristic.

[0047] a. The heated compression tool, which forms the final product geometry, can include surface finishes that translate to the final part.

[0048] 5. The colonized bio composite material can be compressed and dried with a series of heated rollers that narrow in cross-section as the material is conveyed through the process.

[0049] Sheets of bio composite material can be grown together or compressed together with heat to set and dry the final product. The sheets of bio composite material can vary in product density, fiber content, particle size, and fiber orientation to selectively promote specific mechanical properties (screw hold strength, core shear, modulus of elasticity). Additionally, VOCs are not a concern for structural boards produced in this manner because no VOC emitting resins are used in the production process, and the cross-linking occurs between the biochemical construct of the fungal cell wall.

[0050] There are significant mechanical advantages garnered from compressing sheets of mycelium bound particles into a single cohesive product with heightened temperatures (200°F-650°F). These advantages include enhanced modulus of rupture and elasticity (stiffness), and the ability to layer sheets of varying particle size to achieve greater stiffness or dimensional stability (squares, flatness). Other materials, including veneers, textiles, or laminates, that are comprised of wood, plastics (polyester scrim), foam, natural fibers, stone, metal, or the like can be grown and bound to the face or internal structure of the mycelium and particle sheets. These laminates can be stacked and interlaid to the mycelium colonized particle sheets, and then compressed to a desired form (flat or molded).

[0051] The method of the invention allows a final part to have a density between 18 and 60 lbs/ft³, an elastic modulus up to 440 ksi and a modulus of rupture as high as 2500 psi.

Further Variations

[0052] Where the growth media is grown as a solid mass and then ground up to produce particles or pellets with mycelium therein, the particles may be poured into an enclosure of the desired shape and then heated and pressed with the process parameters described above. In this embodiment, the final product has a Modulus of Rupture of 111 psi and a Modulus of Elasticity of 2840 psi.

[0053] The method provides for crosslinking to occur between the glucans in the mycelia that are solubilized during the compression and moisture release process. This can be further mediated with mild acids that assist in protonating and cross-linking.

EXAMPLE 1

[0054] 1. Kenaf pith (screened over a 0.375" screen, 42% of mass), maltodextrin (1.6% of mass), calcium sulfate (0.4% of mass), and water (56% of mass) are mixed in an autoclavable bag to form the substrate for fungal growth. For five liters of substrate, the amount of Kenaf pith is 670 grams (g).

[0055] 2. The bag is sterilized in a pressure cooker at 15 psi and 240°F for 60 minutes.

[0056] 3. Millet grain spawn containing fungal tissue is mixed into the substrate (10% m:m).

[0057] 4. Plastic tool molds that are 6 inches long, 6 inches wide, and 1 inch deep are filled with inoculated substrate.

[0058] 5. The substrate is allowed to colonize in the tool for 7 days at ambient laboratory conditions (75°F, 20% relative humidity, 2000 ppm CO₂).

[0059] 6. Wooden veneers that are 6 inches wide by 6 inches long and a square of porous plastic with same dimensions are soaked in 10% hydrogen peroxide for 30 minutes. This is a chemical disinfection method that also imparts the correct amount of water, since hydrogen peroxide oxidizes to water.

[0060] 7. The substrates in the form of tiles are ejected from the mold and stacked in groups of three with a wooden veneer at each surface and interface and the porous plastic square on the side that will be next to an air inlet during compression.

[0061] 8. The stack of tiles, veneers, and porous plastic is compressed to approximately 3 times density in a compression frame with an air inlet for forced aeration on one side and holes for passive ventilation on the other. For example, as described in Provisional Patent Application 61/860,386, filed Jul. 31, 2103, the disclosure of which is incorporated herein.

[0062] 9. The compression frame is hooked up to an air pump and the compressed substrate is subjected to forced aeration for 5 days. Alternatively, the compressed substrate may be dried within the compression frame with convective or conductive drying.

[0063] 10. The compressed composite body is ejected from the compression frame and placed in an aluminum collar of the same exterior dimensions that surrounds the periphery of the compressed composite body. This collar that has the desired features, locks and creates the features and dimensions required of the final part.

[0064] 11. A heated platens press (at a force of 20 ton and 600°F) is compressed onto the pre-compressed body for two minutes, such that the body is dried to <10% moisture content.

[0065] In this example, the biocomposite material is subjected to compression alone to form a compressed monolithic body, e.g. as described in as described in Provisional Patent Application 61/860,386, filed Jul. 31, 2103, and then subjected to heat and pressure to promote cross-linking between the natural polymers within the mycelium.

EXAMPLE 2

[0066] 1. Kenaf pith (screened over a 0.375" screen, 42% of mass), maltodextrin (1.6% of mass), calcium sulfate (0.4% of mass), and water (56% of mass) are mixed in an autoclavable bag to form the substrate for fungal growth.

[0067] 2. The bag is sterilized in a pressure cooker at 15 psi and 240°F for 60 minutes.

[0068] 3. Millet grain spawn containing fungal tissue is mixed into the substrate (10% m:m).

[0069] 4. Plastic tool molds that are 6 inches long, 6 inches wide, and 1 inch deep are filled with inoculated substrate.

[0070] 5. The substrate is allowed to colonize in the tools (molds) for 7 days at ambient laboratory conditions (75°F, 20% relative humidity, 2000 ppm CO₂).
6. The colonized substrate is ejected from the plastic tool that granted the growing mass its original structure and placed in an aluminum collar that is perforated to allow for water to escape.

7. The colonized substrate is placed in a heated platen press (20 ton, 600°F) and is compressed for four minutes, such that the part is dried to <10% moisture content. The colonized substrate requires between 25 psi and 5000 psi to achieve the maximum compression required. The resulting part has a density of 34 lbs/ft³, a modulus of elasticity around 132 ksi, a modulus of rupture around 1698 psi, and a screw hold strength around 24 lbf at half an inch thickness. By way of comparison, a composite for packaging made in accordance with the methods described in US Published Patent Application 2008/0145577 has a density of from 5 to 8 lbs/ft³.

EXAMPLE 3

1. Kenaf pith (screened over a 0.375" screen, 42% of mass), maltodextrin (1.6% of mass), calcium sulfate (0.4% of mass), and water (56% of mass) are mixed in an autoclavable bag to form the substrate for fungal growth.

2. The bag is sterilized in a pressure cooker at 15 psi and 240°F for 60 minutes.

3. Millet grain spawn containing fungal tissue is mixed into the substrate (10% [m:m]).

4. Growth enclosure molds that are fabricated out of thermoformed polyethylene plastic to the final product geometry or near net shape are filled with inoculated substrate.

5. The substrate is allowed to colonize in the tools (molds) for 7 days at ambient laboratory conditions (75°F, 20% relative humidity, 2000 ppm CO₂).

6. The colonized substrate is ejected from the plastic tool that granted the growing mass its original structure and placed in a structural enclosure of the final product configuration. This second enclosure permits conductive heating and is designed to allow for the installation of embedded inserts or secondary components. The tool is perforated to allow for water to escape.

7. The colonized substrate in the second enclosure is placed in a heated platen press (20 ton, 600°F) and is compressed for four minutes, such that the part is dried to <10% moisture content. The resulting part has a density of 29 lbs/ft³, a modulus of elasticity around 120 ksi, a modulus of rupture around 819 psi, and a screw hold strength around 132 lbf at an inch thickness.

EXAMPLE 4

1. Kenaf pith (screened over a 0.375" screen, 42% of mass), maltodextrin (1.6% of mass), calcium sulfate (0.4% of mass), and water (56% of mass) are mixed in an autoclavable bag to form the substrate for fungal growth.

2. The bag is sterilized in a pressure cooker at 15 psi and 240°F for 60 minutes.

3. Millet grain spawn containing fungal tissue is mixed into the substrate (10% [m:m]).

4. Plastic tool molds that are 18 inches long, 18 inches wide, and 1 inch deep are filled with inoculated substrate.

5. The substrate is allowed to colonize in the tools (molds) for 7 days at ambient laboratory conditions (75°F, 20% relative humidity, 2000 ppm CO₂).

6. The colonized substrate, in the form of a sheet, is ejected from the plastic tool and aligned in a heated pinch press of a desired geometry.

7. The colonized part is pressed and heated (300°F) for one minute, such that the part is dried to <10% moisture content, molded to the desired shape, and excess material trimmed from the final product.

EXAMPLE 5

1. Fabricate the bio composite material into a flat blank board of 1.25" thickness with a 0.25" hemp non-woven mat grown into either face.

2. Press the flat blank board into the predetermined curved shape, such as a shape for a chair back, along with surface features under a compressive force of 3000 psi and 340°F for 10 minutes to lock the surface features and get the board to below 10% moisture.

3. The surface may be obtained by embossing at least one face of the board with a predetermined sculptured feature using an embossing surface on the face of the press that is pressed against the board.

4. When using a mold (tool), a mold release, such as a spray release or a parchment paper, may be used on the surfaces of the mold to enable an easy ejection of the colonized substrate from the mold.

EXAMPLE 6

1. Kenaf pith (screened over a 0.375" screen, 42% of mass), maltodextrin (1.6% of mass), calcium sulfate (0.4% of mass), and water (56% of mass) are mixed in an autoclavable bag to form the substrate for fungal growth. For five liters of substrate, the amount of Kenaf pith is 670 grams (g).

2. The bag is sterilized in a pressure cooker at 15 psi and 240°F for 60 minutes.

3. Millet grain spawn containing fungal tissue is mixed into the substrate (10% [m:m]).

4. The substrate is allowed to colonize in the tools for 7 days at ambient laboratory conditions (75°F, 20% relative humidity, 2000 ppm CO₂).

5. The colonized substrate is dried to 30% moisture in a forced convection oven at 180°F for 12 hours.

6. The resultant mass is hammer milled through a 0.125" screen, and then passed over a 38 mesh screen to remove fines.

7. The particles are positioned in a heated cavity at 380°F, and then compressed into the molded cavity with a featured platen under 30 tons of force. The materials are held for four minutes.

8. The final product is ejected and allowed to cool to room temperature before loading.

9. In a further variation of the method, the mycelium can be grown out separately and then added at a 10% moisture content to a collection of dried discrete particles as set forth in the following examples.
EXAMPLE 7

[0100] Mycelium is cultivated on malt extract (32 g per liter) for 7 days at ambient laboratory conditions (75°F, 20% relative humidity, 2000 ppm CO₂) until a sheet of mycelium is formed.

[0101] The harvested mycelium sheet is freeze dried.

[0102] The resultant mass is hammer milled through a 0.0625" screen.

[0103] Kenaf pith is hammer milled through a 22 mesh and over a 38 mesh screen.

[0104] The kenaf pith and mycelium fragments are blended together at a 9:1 ratio (m:m).

[0105] The blended together particles are positioned in a heated cavity at 380°F, and then compressed into a mold cavity with a featured platen under 30 tons of force and held for four minutes to form a cohesive product.

[0106] The final product is then ejected from the mold and allowed to cool to room temperature before loading.

[0107] The resultant product offered a 31 lb/ft³ density, a MoR of 206 psi, and a MoE of 27050 psi.

EXAMPLE 8

[0108] Mycelium is cultivated on malt extract (32 g per liter) for 7 days at ambient laboratory conditions (75°F, 20% relative humidity, 2000 ppm CO₂) until a sheet of mycelium is formed.

[0109] The harvested mycelium sheet is freeze dried.

[0110] The resultant mass is hammer milled through a 0.0625" screen.

[0111] The mycelium particles are positioned in a heated cavity at 380°F, and then compressed into a mold cavity with a featured platen under 30 tons of force and held for ten minutes to form a cohesive product.

[0112] The final product is ejected and allowed to cool to room temperature before loading.

[0113] The resultant product (i.e., compressed mycelium) offered a 42 lb/ft³ density, an MoR of 507 psi, and an MoE of 48525 psi.

[0114] The invention thus provides a compressed composite body of particle/mycelium that is characterized in being a rigid body having a density in the range of from 18 to 60 lbs/ft³, a modulus of elasticity of up to 250 ksi (1 k=1000 psi) and a modulus of rupture of up to 2500 psi.

[0115] The compressed composite bodies of the invention that are pressed to 0.25" or less achieve these above metrics. The use of particles in the bodies normally obtain a modulus of elasticity under 250 ksi, whereas the use of fibers instead of particles can obtain a modulus of elasticity well above 250 ksi since the fibers bear more of the tensile strength in flexure.

[0116] The compressed composite body made in accordance with the method described herein differs from a compressed composite body made in accordance with the methods described in patent application Ser. No. 14/336,385, filed Jul. 21, 2014, inter alia, in that due to conductive drying, the glucans are cross-linked and all the water is removed.

[0117] The composite body made in accordance with the invention may be subjected to further processing steps to achieve a desired final product. For example, the composite body may be die cut to a desired three-dimensional shape; drilled or cut to provide openings therein; and the like.

[0118] Further, an assemblage of flat sheets of biocomposite material, sheets of woven or non-woven laminations and inserts of three-dimensional contour (i.e., inserts on non-flat as well) may be heated and pressed together to form a desired final product having an internal shape corresponding to the inserts.

What is claimed is:

1. A method of making a composite body comprising the steps of:
   a. obtaining a mass of biocomposite material comprised of discrete particles, a network of interconnected glucan-containing mycelia cells extending around the discrete particles and a moisture content of from 45% to 70%;
   b. placing the biocomposite material in a compression fixture;
   c. heating the biocomposite material in the compression fixture while compressing the biocomposite material into a compressed body of a desired density and shape within said compression fixture;
   d. maintaining the compressed body under heat and compression for a time sufficient to allow cross-linking between the glucans in said mycelia cells to bind the discrete particles together in the compressed body;
   e. removing the compressed body from the compression fixture;
   f. heating the removed compressed body to dehydrate the compressed body to reduce said moisture content to less than 50% and to deactivate the mycelia cells.

2. A method as set forth in claim 1 wherein said step of heating reduces said moisture content to a range of from 6% to 30% to impart electrical conductivity to the removed compressed body.

3. A method as set forth in claim 1 wherein said step of heating reduces said moisture content of less than 10%.

4. A method as set forth in claim 1 wherein said step of heating includes heating the biocomposite material to a temperature of from 250°F to 650°F while compressing the biocomposite material at a pressure of from 10 to 1500 psi.

5. A method as set forth in claim 4 wherein said step of heating includes heating the biocomposite material to 300°F.

6. A method as set forth in claim 4 wherein the biocomposite material is compressed for a time of between 4 minutes and 15 minutes.

7. A method as set forth in claim 1 further comprising the step of placing a lamination on a surface of the biocomposite material in the compression fixture prior to said step of heating the biocomposite material whereby the lamination is integrated into the compressed body.

8. A method as set forth in claim 1 wherein said compression fixture includes at least one insert for pressing into the biocomposite material during said step of heating the biocomposite material.

9. A method as set forth in claim 1 wherein said compression fixture is a pinch press for compressing the biocomposite material into a compressed body in a batch-like manner.

10. A method as set forth in claim 1 wherein said compression fixture includes a series of heated rollers defining a path of narrowing cross-section for compressing the biocomposite material into a compressed body in a continuous manner.

11. A method of making a composite body comprising the steps of:
   a. obtaining a mass of biocomposite material comprised of discrete particles, a network of interconnected glucan-containing mycelia cells extending around the discrete particles and a moisture content of greater than 10% by weight;
molding said mass into a plurality of tiles of rectangular shape;
stacking said tiles in alternating manner with a plurality of wooden veneers and with a plate of porous plastic on an underside thereof to from a stack;
compressing said stack to compress said tiles to approximately three times density while drying the compressed tiles to obtain a pre-compressed biocomposite body;
thereafter compressing said pre-compressed biocomposite body at a force of 20 tons and at a temperature of 600°F for a time of two minutes while reducing the moisture content to less than 10% to obtain a compressed composite body.

12. A method as set forth in claim 11 wherein said compressed composite body has a density of 20 lbs/ft³, a modulus of elasticity around 80 ksi, a modulus of rupture around 800 psi, and a screw hold strength around 100 lbf.

13. A method of making a composite body comprising the steps of
obtaining a mass of biocomposite material comprised of discrete particles, a network of interconnected glucan-containing mycelia cells extending around the discrete particles and a moisture content of greater than 10% by weight; and
thereafter compressing said mass at a pressure between 25 psi and 5000 psi and at a temperature of 600°F for a time of four minutes while reducing the moisture content to less than 10% to obtain a compressed composite body.

14. A method as set forth in claim 13 wherein said compressed composite body has a density of 34 lbs/ft³, a modulus of elasticity around 132 ksi, a modulus of rupture around 1698 psi, and a screw hold strength around 24 lbf at half an inch thickness.

15. A method as set forth in claim 13 wherein said compressed composite body has a density of 29 lbs/ft³, a modulus of elasticity around 120 ksi, a modulus of rupture around 819 psi, and a screw hold strength around 132 lbf at an inch thickness.

16. A method of making a composite body comprising the steps of
obtaining a mass of biocomposite material comprised of discrete particles, a network of interconnected glucan-containing mycelia cells extending around the discrete particles and a moisture content of greater than 10% by weight; and
thereafter compressing said mass at a pressure between 25 psi and 5000 psi and at a temperature of 300°F for a time of one minute while reducing the moisture content to less than 10% to obtain a compressed composite body.

17. A method as set forth in claim 16 wherein said mass is molded into a sheet prior to said step of compressing and pressed into a deformed geometric shape.

18. A method as set forth in claim 17 wherein said sheet has dimensions of 18 inches by 18 inches by 1 inch and said deformed geometric shape is a semi-cylindrical shape.

19. A method of making a composite body comprising the steps of
obtaining a mass of biocomposite material comprised of discrete particles, a network of interconnected glucan-containing mycelia cells extending around the discrete particles and a moisture content of greater than 10% by weight;
forming said mass of biocomposite material into a flat blank board of 1.25" thickness with a 0.25" hemp non-woven matt grown into at least one face of said flat blank board;
thereafter compressing said flat blank board into the predetermined curved shape under a compressive force of 3000 psi and at a temperature of 340°F for a time of 10 minutes while reducing the moisture content to less than 10% to obtain a compressed composite body of curved shape.

20. A method as set forth in claim 19 wherein said step of forming said mass of biocomposite material into a flat blank board includes embossing said at least one face with a predetermined sculptured feature.

21. A method of making a composite body comprising the steps of
cultivating mycelium into a sheet;
freeze drying said sheet;
thereafter milling said dried sheet to form a first mass of particles;
milling Kenaf pith to form a second mass of particles;
blending said first mass of particles and said second mass of particles into a mixture;
thereafter heating and compressing said mixture in a mold cavity for a time sufficient to form a cohesive product; and
removing said product from the mold as a self-supporting composite body.

22. A method as set forth in claim 21 wherein said step of cultivating mycelium into a sheet includes cultivating the mycelium on malt extract at a rate of 32 g per liter for 7 days at ambient conditions of 75°F, 20% relative humidity and 2000 ppm CO₂, until said sheet of mycelium is formed.

23. A method as set forth in claim 21 wherein said step of milling said dried sheet includes hammer milling through a 0.0625" screen.

24. A method as set forth in claim 21 wherein said step of milling Kenaf pith includes hammer milling through a 22 mesh and over a 38 mesh screen.

25. A method as set forth in claim 21 wherein said step of blending blends said kenaf pith and said mycelium together at a 9:1 ratio.

26. A method as set forth in claim 21 wherein said step of heating and compressing said mixture includes heating the mold cavity to 380°F and compressing said mixture under 30 tons of force for four minutes to form the cohesive product.

27. A self-supporting composite body comprising a substrate of discrete particles and a network of interconnected mycelia cells extending through and around the discrete particles and bonding the discrete particles together, said composite body being characterized in being stiff and in having a density between 18 and 60 pounds per cubic foot (pcf), a modulus of elasticity of up to 250 ksi and a modulus of rupture of up to 2500 psi.

28. A self-supporting composite body comprising a substrate of discrete fibers and a network of interconnected mycelia cells extending through and around the discrete fibers and bonding the discrete fibers together, said composite body being characterized in being stiff and in having a density between 18 and 60 pounds per cubic foot (pcf), a modulus of elasticity greater than 250 ksi and a modulus of rupture of up to 2500 psi.