



# BIOPLASTICS

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Emerging Materials



## About the material

Cork Composites are bound in a plastic that allows them to be heated and formed into any imaginable shape. They are completely recyclable and depending on the use the cork can be made very strong and rigid or thin and flexible. Enhanced through polymerization, the material has great sound insulating properties and perfect for heat isolation.

## Applications



Insulation



Product Design



Sound Proofing

## Sustainable Factors

The material can be recycled completely helping maintain a healthy consumption of the cork polymers, and can become biodegradable after being enhanced by certain chemicals.

Limiting Factors – Cork has virtually no limiting factors, it has become the go to material for exploration amongst 21st century designers and manufacturers for its light volumetric abilities.

## Brands



The Amorim Group is one of the largest, most entrepreneurial and dynamic multinationals of Portuguese origin



Materials experts from WACKER, working together with the world's largest cork producer and two machine manufacturers, have developed a novel cork composite.



Portugal supplies 70% of the world's corks and cork products and CorkLink is a group of cork factories based in northern Portugal that can supply pretty much anything you need made from cork.



## About the material

Cellulose is the most common organic compound in the world, as it is found in all plants. Plastics based on cellulose can attain a 90% permeability. The raw material is colorless and contains self-polishing properties. Cellulose based plastic can take any form, making them highly sought after in a wide range of industry sectors. It does although require a softener for certain types of processing.

## Applications



## Sustainable Factors

Cellulose can be easily found and relatively cheaply made, therefore it serves as an excellent replacement product. It is 100% recyclable in its pure form, yet it does not biodegrade.

Limiting Factors: There are no true limiting factors currently affecting this product as it can be widely sourced and indefinitely combined to produce any product.

## Brands



Manufactured for lightweight insulation purposes and as lightweight building materials. Moniflex benefits from its translucent, bend resistant, and long-lasting properties. It can also be tooled in current industry standards and is biodegradable.



Made completely from cellulose fibers of plant origins. Zelfo is transformed into a pliable mass without the use of water or adhesive. This mass can be injection molded and extruded. used primarily in the consumer products and furniture sectors.



Made from the processing of grass, Agriplast is manufactured without the use of solvents and adhesives. AgriPlast contains an estimated 75% cellulose granulate and 25% polypropylene mix. Components made from Agriplast are typically 20% lighter.



## About the material

PHB is expected to replace (PP) in several sectors in the coming years as it is fully biodegradable and adaptable to the fields of PP. It has extensive application variation by itself or in a blend of any type to achieve the desired properties. Furthermore depending on the compound PHB can be used as an adhesive or a hard rubber. Yet, PHB has high fracture susceptibility and if temperatures exceeded 195C PHB will depolymerize.

## Applications



## Sustainable Factors

During the last decade, much attention has been focused on the production of bacterial polyesters. Different bacterial types of microorganisms produce PHB from renewable sources from sugar and molasses as intracellular storage materials. To produce PHB, you can feed corn syrup, beet molasses or any number of other carbon-based energy sources to a culture of bacteria placed under specific stress conditions. In response, the bacteria build the sugars into granules of PHB -- essentially, in an effort to preserve them for later metabolism.

Limiting Factors: Production cost of PHB are by far its greatest limiting factor. Furthermore there are still yet few capable facilities of producing PHB. Currently 3kg of sugar can be made into 1kg of PHB.

## Brands



A PHB thermoplastic that is heat resistant, waterproof, and completely biodegradable. Can be molded and tooled with conventional processes and can be used for thin-walled components and complex geometry.

The manufacturer specializes in the mass production of PHB, it not only creates granules, but adapts it into many forms such as films and sheets.



## About the material

PLA is one of the most important bio crude plastics in the development of sustainable future. PLA plastic is a clear, nature-based green packaging option made entirely from corn or sugarcane. With a look and feel similar to PET plastic. The raw material is colorless, shiny and can be compared to polystyrene. It is however prone to softening at lower temperatures. As it is a bio crude plastic, it must be mixed with aggregates and additives to achieve the desired performance required for manufacturing. PLA plastics have gained an interest for food packaging and other manufacturing sectors.

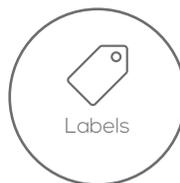
## Applications



Bottles  
& Jars



Food  
Packaging



Labels



Textiles

## Sustainable Factors

PLA is made from corn starch or any type of sugar. Due to its chemical composition, PLA is completely degradable. PLA will not biodegrade by itself on any shelf, in order to degrade, PLA must be exposed to temperatures greater than 140°F and relative humidity greater than 90% for approximately 60 to 80 days. Furthermore, PLA does not produce toxic fumes when incinerated.

Limiting Factors: PLA is currently transforming the way packaging is created, as it becomes ever more sustainable. Unfortunately due to relative youth of the material, there is a lack of infrastructure for it to replace oil based plastics. Both for the manufacturing of PLA and the recycling of it, as it requires industrial facilities for it to compost. Furthermore PLA can contaminate other recyclable plastics if it is mixed in when they are being recycled such as PETE.

## Brands



As the world's largest producer of PLA, the company has developed a method for transforming the natural occurring sugars into a patented polymer

Produced on a basis of renewable resources, it contains 45% PLA and the rest can be modified to achieve the desired performance.



## About the material

80% of all global bio plastic production originates from TPS sourced polymers. Making it by far the most widely used biodegradable plastic available. Created from corn, grains and potatoes, TPS can be fabricated anywhere in the world. TPS is typically found in a blend of some sort, this is due to its high ability to absorb water. TPS polymers can be either found in solid form or flexible materials.

## Applications



Eating Utensils



Food Packaging



Protective Packaging



Trash Bags



Pharmaceuticals

## Sustainable Factors

Starch found in TPS is renewable, readily biodegradable, easily modified both physically and chemically, and available in bulk in all parts of the world at low cost making it a very attractive raw material for manufacture of "green" plastics. And in its pure form, it is 100% biodegradable, with an energy efficient production capability.

Limiting Factors: Besides having to be blended to achieve its maximum potential. There are moral issues associated with TPS production as it claims from food supplies.

## Brands



Primarily designed as a thermoplastic for injection molding, it is found in the packaging sector. Furthermore it can be extruded into foils.



As a completely biodegradable solution made from potato starch, Biopar resembles the qualities of PVC, due to its ability to retain gasses and moisture



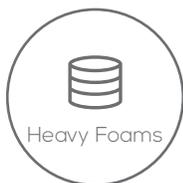
A unique approach to the manufacturing of TPS as it is made from potato starch and possess amazing qualities. It is 100% edible, water soluble and biodegradable.



## About the material

Vegetable oils are generally considered to be the most important class of renewable resources, because of their ready availability, inherent biodegradability, and numerous applications. A variety of vegetable oil-based polymers have been developed by free radical, cationic, olefin metathesis, and addition polymerization. The polymers obtained display a wide range of thermo physical and mechanical properties from soft and flexible rubbers to hard and rigid plastics, which show promise as alternatives to petroleum-based plastics.

## Applications



Heavy Foams



Industrial  
Plastics



Protective  
Packaging



Trash Bags



Pharmaceuticals

## Sustainable Factors

Based on renewable resources and have a low CO<sub>2</sub> footprint over their lifecycle. Yet depending on the compound they be not always biodegradable.

Limiting Factors: These plastics are currently under heavy development and not available in mass quantities.

## Brands



Lupranol: A product that results in the creation of soft foams with a 31% content of castor oil.



Vestamid Terra: Consisting largely of castor oil and fatty acids. Vestamid creates high performance polyamides which result in the suitable creation of fiber glass reinforced masses. This material is further being developed



A polyamide from castor oil that creates a plastic that is optimal for the creation of plastic parts in the automotive industry.



## About the material

Almond composites consist of "Maderon" which is a mixture of ground almond shells consisting mainly of cellulose and lignin. The mixture can be molded into any desired shape and is used in manufacturing and interior design. It is airtight and decomposes when buried.

## Applications



Furniture



Interior  
Design



Coffins

## Sustainable Factors

Replaces Wood with plant waste products, grows quicker than wood and also can be implemented as a resin.

## Brands



A Spanish company focusing on bringing the best use of almond shells for funeral services and furniture



MastAlmond : Conceived for the development of new plastic colorants based on biodegradable polymers with almond shell targeted to the toy and auxiliary furniture industries and able to be transferred to other industries.

*Duralmond*

Duralmond is a composite material obtained by mixing natural and synthetic resins, crushed almond shells and other additives



## About the material

Algae is a material available anywhere in the world and is very easy to cultivate. It is typically made in the form of fiber algae and treated while wet with a resin system.

## Applications



## Sustainable Factors

Due to the rapid growth in almost any environment, including mold tooling, this material requires little-to-no valuable agricultural land, and does not compete for a food source. The foaming effect is created by passing air through the organism and therefore no environmentally harmful Chlorofluorocarbons (CFC's) are used in production. The product can also be composted and/or recycled with such items as waste paper after its use is completed.

Limiting Factors: It is very new and so there is still a lot of experimental work and analysis being done

## Brands

### Cereplast

Cereplast creates a wide range of bioplastic resins to meet surging consumer and industrial demand for alternatives to traditional plastics.



The Algae Biomass Organization promotes the development of viable technologies and commercial markets for renewable and sustainable products derived from algae.



## About the material

Fungus material is grown and typically found in Rice or wheat remains and then formed into predetermined shapes. All products are completely biodegradable, recyclable and perfect for substituting Styrofoam.

## Applications



## Sustainable Factors

Sustainable Factors – the incredible thing about Fungus based composites is that they are completely organic and biodegradable making them perfect for replacing one time uses of Styrofoam.

## Brands



Greensulate is a leader of integrated design, engineering, installation and maintenance of Green Roof Systems for the residential, commercial, and industrial markets.



Driven to produce materials that are healthier for people, the planet, and profits based on high performance biomaterials grown from mycelium and agricultural waste



## About the material

Plant fiber composites are biopolymers that are taken from hemp, kenaf, abaca, and coconut and are mainly used to serve as support materials. The composites when mixed form a strong interwoven hair like substance that can also be molded and mixed with adhesives to form strong molds.

## Applications



Seating



Support



Interior Design

## Sustainable Factors

The fact that a lot of the fibers can be extracted from common plants themselves, makes them easily accessible. They are also biodegradable.

## Brands

**GreenCore**  
Naturally Strong

GreenCore is a leading Cleantech manufacturer of NCell™ Natural Fiber reinforced thermoplastics for injection molding and extrusion applications.

**BARK**  
**CLOTH**

BARK CLOTH® is cultivated from Mutuba trees (*Ficus natalensis*) on our eco clearpixel-certified farms in Uganda. It is 100% plant fiber, an authentic organic "living" clearpixelcloth at the interface between textile and wood

# LINOLEUM



## About the material

Made predominantly from Linseed oil, Linoleum is a floor covering, non-slip surface that usually is used for interior design and textile covering. Given its high resistance to oils and fat it is extremely durable

## Applications



## Sustainable Factors

Based on renewable resources and have a low CO2 footprint over their lifecycle. Yet depending on the compound they be not always biodegradable.

Limiting Factors: These plastics are currently under heavy development and sometimes available in mass quantities.

## Brands



Linoleum flooring is made from natural materials like linseed oil, recycled wood flour, cork dust and limestone. Linoleum is naturally anti-bacterial and biodegradable. If you are looking for a "green" floor for your home, linoleum is one of the best choices

Vestamid Terra: Consisting largely of castor oil and fatty acids. Vestamid creates high performance polyamides which result in the suitable creation of fiber glass reinforced masses. This material is further being developed

Forbo Flooring Systems is the global market leader in linoleum floor coverings, owning a market share of over 60%.



## About the material

Bark Cloth is an ancient material extracted from trees, and mixed with textile additives to become water resistant, taking on leather-like characteristics. The material is very common in many places in Southeast Asia. The process requires long sheets of the tree trunk to be stripped and hammered, later left to dry and coated with oils for extended periods of time to curate the material.

## Applications



Furniture



Textiles



Interior  
Design



Stage  
Construction

## Sustainable Factors

Coming from tree trunks, the material is very organic and easy to manufacture. although it is farmed in a small scale. The material is biodegradable and very light weight, enhancing its shipping and utilization methods.

## Brands



BARK CLOTH® is cultivated from Mutuba trees (*Ficus natalensis*) on our eco clearpixel-certified farms in Uganda. It is 100% plant fiber, an authentic organic "living" clearpixelcloth at the interface between textile and wood

# STYLEPARK

BARK CLOTH® is cultivated from Mutuba trees (*Ficus natalensis*) on our eco clearpixel-certified farms in Uganda. It is 100% plant fiber, an authentic organic "living" clearpixelcloth at the interface between textile and wood



## About the material

Maize cob board is a material used for sandwiching between planks or pieces of wood, that consist of dried up corn cobs. With foam like characteristics, the material has a low density and is highly durable. It is 50% lighter than conventional wood panels making it highly attractive to be used as support material.

## Applications



## Sustainable Factors

Since the material comes from the after use of corn cobs, which is one of the leading products used for virtually anything around the world, it increases the utility and desirability of completely using the corn cobs even after extracting the kernels

## Brands

Companies are currently in development but the product can be purchased from China wholesaler "Alibaba" right now.



## About the material

Lignin is a complex hydrocarbon found in the walls of plant cells, making them rigid and wood-like. This bio-polymer is responsible for the structural support, or skeleton, of all rigid plant life, accounting for 30% of a tree's mass.

## Applications



## Sustainable Factors

Lignin-Based Bioplastics are derived from raw organic material, as well as the waste of other manufacturing processes. According to Biomeoplastics.com, Europe's pulp and paper industry, which only use cellulose fibers (40-45% of wood's mass), produce 100 million tons of paper per year, requiring 222 million tons of wood for production. This produces 66 million tons of discarded lignin during pulp and paper production in Europe, alone.

Limiting Factors: Lignin synthesis and production requires a complex and costly process requiring hazardous chemicals including methanol and hydrochloric acid. Study of 5 lignin-degrading enzymes found in termites however, by Professor Tim Bugg at England's Warwick University, could vastly decrease production costs.

## Brands



Trade name: Liquid Wood. Injection moldable polymer made from lignin, cellulose and proprietary additives. Can be colored, and molded.



LegnoChem is a leading North American distributor of several environmentally friendly and economical lignin (lignosulfonates) based products.



Lignin is a main component of wood and has unique properties. We are the only-one lignin manufacturer in Japan and we produce wide range of lignin products.



## About the material

Chitin is the main component in the skeletons of spiders, cell walls of fungi, as well as the exoskeletons of crabs and insects. The molecular structure of this polysaccharide (a carbohydrate chain like that of edible starches) exhibits soluble characteristics in water and alkaline solutions, which result in styptic (coagulant reactions when placed on wounds) as well as antibacterial properties desired in the medical and biotech manufacturing. It also acts as an oxygen barrier.

## Applications



Medical



Agricultural



Purification



Fiber  
Manufacturing

## Sustainable Factors

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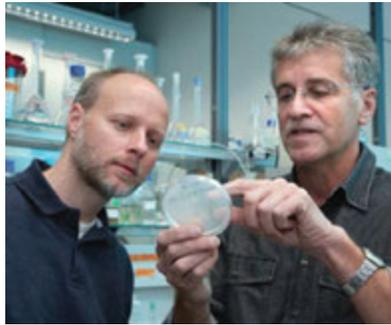
## Brands



The hemostatic HemCon Bandage PRO provides a patient with the time needed to either reach care or gain the critical time to clot. The HemCon Bandage PRO provides the medical professional a solution that is quick-acting, natural, localized and effective



BioElectric challenges the archetypes of electronics through material exploration. Industrial processes have streamlined manufactured products, but what if we allow new materials to be expressive and tactile?



## About the material

A proprietary enzyme discovered in a bacterial strain called 2-hydroxyisobutyryl-CoA mutase, which was discovered by Thore Rohwerder in 2008, has been shown to break down renewable resources, such as sugar, into the precursor of Methyl Methacrylate (MMA), the base polymer of Polymethylmethacrylate (Trade name "Plexiglas")

## Applications



## Sustainable Factors

Due to its production, using a fast growing, renewable resource—like sugar, an enzyme found naturally in bacteria, and other naturally occurring ingredients, could replace commonly found acrylic "Plexiglas" made from fossil fuel sources. This production method would not only be more eco-friendly, but would also require less energy during production, and would reduce waste products.

Limiting Factors: Due to the current research, and ongoing testing, the product has not been put into production.

## Brands



From plants to plastics, making Ingeo is a completely new and innovative process. Our technology is found nowhere else in the world and provides an eco-friendly option in many segments



## About the material

Natural rubber (a natural elastomer), a renewable resource that comes from the Hevea Brasiliensis plant ("rubber tree") in the form of latex, is found in 40% of all industrial rubber production. A resilient fungus, currently affecting rubber tree growth and health, has left the latex procurement industry devastated. In search of an alternative source, scientists have discovered that dandelion milk to have similar properties to that of latex.

## Applications



Natural Latex



Industrial Use



Textiles



Hoses



Flooring

## Sustainable Factors

Dandelions grow at an exponentially faster pace, compared to the "rubber tree". Require less resources and land to grow. It will require less energy consumption in all phases of production and create less waste.

Limiting Factors: This new source of latex-like material polymerizes immediately at the time of extraction. The enzyme responsible for this has been identified and genetic modification is still in the research stages.

## Brands



Astlett Rubber serves an important and essential role in supplying a vital industrial raw material. We provide natural rubber, which is produced as an agricultural product half a world away, and synthetic rubber, mostly from producers outside North America



As a natural rubber manufacturer, Artemis Rubber has the experience and expertise to help your company go green.



A prominent firm engaged in the commerce of Raw Rubber and Rubber Chemicals.



## About the material

Often referred to as “liquid wood”, the composite material consists of wood fibers, a polymer compound (often PP, PE, or PLA) and various proprietary additives, this composite can be processed and molded like a thermoplastic. The amount of wood fiber can range anywhere from 50-90%, and boasts low shrinkage, little to no thermal expansion, high structural rigidity, and can be formed into high precision parts

## Applications



## Sustainable Factors

Made primarily of renewable materials, it reduces the amounts of oil-derived polymers in product production. Has the ability to replace the use of expensive, rare tropical hardwoods, and when produced with natural plant plastics is biodegradable.

Limiting Factors: The higher the percentage of wood fibers used in production, the less wood fiber direction created in the final product—thus distorting/negating the natural wood grain appearance.

## Brands

**FASAL WOOD**  
Production & Development



**KUPIILKA**

Producers of mass-manufactured products with wood and corn fibers, optimized for injection molding processes. Products exhibit very hard surfaces, wood-like appearances, and high bendability.

Using a composite of 75% raw materials (wood fibers), and 25% polymers and other proprietary additives. Boasts mold resistance and has a main product demand in patio, garden, and balcony decks.

This product employs a 50/50 composition of wood fibers and polymers. This produces a product with higher heat resistance, more hygienic, and more stability in comparison to wood.



## About the material

Coconut wood's uses are growing as the consumer market pushes to not use exotic hardwoods, and therefore depleting rainforests. Having no internal ring structure (like the ones used to tell the age of a typical tree), it has a tubular structure which runs the length of the grain, giving the cross-sections a "spotted" pattern

## Applications



## Sustainable Factors

Coconut palms are only considered to be fertile (able to bear fruit) for 70 years. At the end of this period, the tree has reached the end of its economic life, and is cut down to make way for new trees in its stead. Globally, some 70 million coconut palms are cut down annually. Until this new market for their wood was discovered, the wood was considered a waste product of coconut plantations.

Limiting Factors: Made from the felling (cutting down) of [economically] dead coconut palms, there is only so many trunks cut down per year, therefore limiting the amount of raw coconut wood for world production.

## Brands

**EKOBE**<sup>®</sup>  
REVESTIMENTOS ECOLÓGICOS

This manufacture specializes in prefabricated coconut wood mosaics, for decorative floor, wall, and furniture coverings.

**Kokoshout.nl**

Dutch Manufacturer. Coconut Wood is made from the coconut palm. The coconut tree is 20 to 40 meters high and the diameter of the trunk varies from 20 to 35 cm. The palms are not thicker, just longer.

**plyboo**<sup>®</sup>

Smith & Fong company added the Durapalm as an alternative to bamboo flooring. Durapalm's coconut palm and sugar palm flooring enhances any interior with the distinctive luxury of the tropics



## About the material

Growing to a height of nearly 131 feet with a stalk diameter of half a foot, the bamboo wood is [25%] harder than oak, and is high vibration absorbative. Growing at an astonishing rate, it is an extremely important building material in many regions of the world.

## Applications



## Sustainable Factors

Bamboo can grow to a height of nearly 40 meters with stem circumferences of up to half a meter. The wood is 25% harder than oak and more durable than hardwoods.

Limiting Factors Although it is bend and absorb vibrations, bamboo is known for splintering. If used in outdoor applications, it is necessary to protect the wood from moisture, as well as insect damage and fungal decay.

## Brands



Teragren PureForm bamboo veneers were used to custom mold of the patent-pending airfoils for the Haiku, the first residential ceiling fan by Big Ass Fans.



An EcoTimber hardwood flooring is more than just beautiful hardwood, cork, or bamboo flooring. Since 1992.



Cali Bamboo's mission is to promote the use of bamboo as a new material for everyday products. It is our hope, that by providing alternative products made from renewable resources.



## About the material

In effort to take lower-quality woods (ones that are more susceptible to the elements), and make them suitable for outdoor applications, the use of several methods of heat-treating have increased in production.

## Applications



## Sustainable Factors

Uses lesser-quality woods, some found near the construction sites and less tropical and rainforest woods. Heat treating raw lumber lowers the risk of cracking, and increasing their durability. Less energy has to be expended, as local woods can be used, lowering the need for exotic woods to be brought to the site from many miles away.

## Brands



Menz Holz's production utilizes natural rapeseed oil, heated to 220°C, to treat and darken lesser quality woods, making them look and act like tropical woods.



This company uses multiple treating processes with no added chemicals, making a much more sustainable product. These products are used in are used for indoor flooring and panels.



Using the acetylation process, the swelling properties of lesser quality woods are reduced, while stability is increased, to a comparable level of "almost all tropical woods"



## About the material

This process of heating either wood timbers or lumber to 140-200°C while compressing it up to 5 MPa (Megapascals) (5MPa = 725 PSI), the density of coniferous (trees with needles for leaves) is increased exponentially, having the porosity reduced by 60%. These treated timbers also boast an increased environmental and biological resistance.

## Applications



Interior  
Design



Outdoor



Lightweight  
Construction



Packaging

## Sustainable Factors

Due to increased density, and compression into roughly the desired shape, the waste production is avoided, almost entirely. This process also requires less energy consumption than that of Wood Polymer Composites. Increasing the density of cheaper, more populous woods, increasing their mechanical and structural properties, decreases the need for more exotic hardwoods.

## Brands



For more than 60 years the company AMANDUS KAHL has built pelleting presses, which proved to be successful due to their robust construction, their economic efficiency, and their smooth running performance.



The ThermoWood® trademark is a sign of wood products manufactured via a method developed in Finland