ACTAsia - The Researcher Team 2

Anni Zhu, Jingwei Xie, Lanxin Yang

2021.12.08

Introduction

In the near future, we will see an acceleration of problem-solving priorities driven by scant material resources, as industries pivot around sustainable innovations. Innovators will push forward progress on natural, renewable material sources, recycling industry and regenerative practices as solutions are sought that will actively improve nature's ecosystems rather than just do less harm.

This assessment report divides the nine materials into three main categories Planet-based material, Bio-based leather alternatives and manmade recyclable synthetic, and compares and contrasts them in terms of material characteristics, production processes, to environmental impact etc.

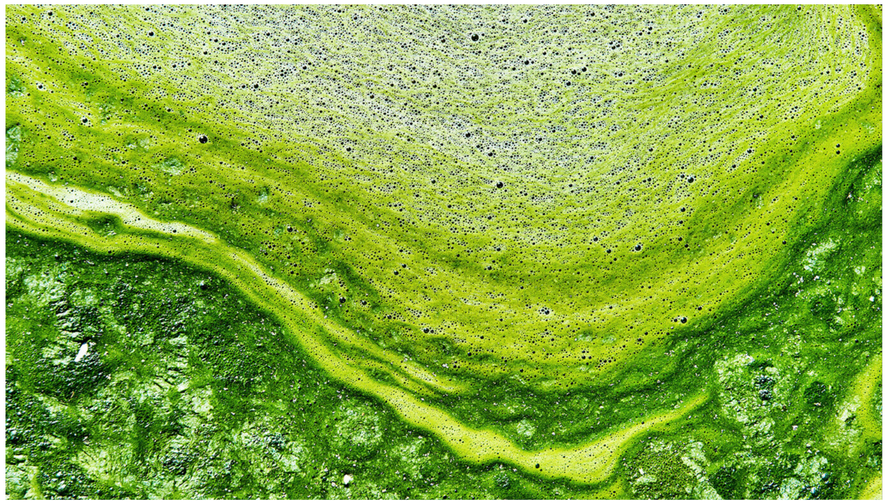
Contents

Plant-based Material

The need for progressive eco-friendly innovation is imperative, As living plant-based materials such as algae and mycelium begin to scale up and become more vigorous, plant-based materials will gain attention. Plant-based materials are scalable and attract consumer interest. The innovation of plant-based materials will continue to appear as substitutes for petroleum-derived products.

For example, FRUTFIBER™ repurposes food waste, turning banana leaf fiber, pineapple leaf fiber and bamboo into a new, innovative fabric. PLNTFIBER™ uses renewable, fast-growing plants such as Himalayan nettle, bamboo, eucalyptus and seaweed

Plant-based Material - Algae



The character of brewed Algae:

- The diversity of the habitatsDiversity of forms.
- Good adaptability
- Natural advantage

Manufacture:

- Grow algae in biocreaters
- Seperate the algae
- Print the algar onto T-shirt

The role of Algae in fashion industry:

- T-shirt
- Bio-plastic
- Pollution control

Environmental impact:

- Consumes carbon dioxide and produces up to 50%-80% of the oxygen on earth

Disadvantages and limits:

- Some algae may be warmful to humanity

Tech:

- Berlin-based algae pioneers Essi Johanna Glomb and Rasa Weber who recreated a technique used in Kenya to create algae cake

Plant-based Material - Brewed Protein

The character of brewed protein:

- Totally vegan.
- Diversity of forms.
- Delicate as silk.
- Soft and warm as cashmere.
- Ethically manufacture.
- It is 100% biodegradable.
- Strong, flexible, thin, lightweight and elastic.

Manufacture:

Using plant-derived sugars.

Designs genes.

Microorganisms are engineered to produce these proteins.

Separate proteins.

Dry purified protein.

Tech:

- Spiber’s proprietary fermentation process.
- Microbial fermentation technology.

The role of brewed protein in fashion industry:

- Fur and leather alternatives.
- Resembling tortoiseshell or animal horn alternatives.
- Cotton and polyester alternatives.

Disadvantages and limits:

- The cost is high.
- No big scale yet.

Environmental impact:

- In-house technology leads to no carbon emissions.
- No involving petrochemicals.
- Not to create or break down into environmentally-persistent micro-plastics.
- It avoid something that happens when tiny fibres wash out during the process of doing laundry.

Plant-based Material - Organic Linen

The character of organic linen:

- Durable
- Resilient
- Comfort
- Air permeability
- Easy washing
- Better structural properties

Manufacture:

- Cultivation
- Harvesting
- Preparation of the Fiber
- Ripping/ Retting
- Breaking
- Scutching
- Hackling
- Spinning

The role of organic linen in fashion industry:

- Home furnishings
- Apparel textile
- Footwear
- Accessory

The disadvantages of organic linen:

- More difficult to spin than other fabrics
- Organic flax accounts for only 1% of the flax produced and is therefore a very rare
- Expensive

Environmental impact:

- Most biodegradable
- Organic flax production without the use of pesticides
- Organic flax production requires 80% less energy
- Every part of the organic flax plant can be used without any waste
- Minimal water consumption during growth

Tech:

- Separation of fibre from woody stems using the "Retting/Rapping" technique
- Textile Technology

Bio-based Leather Alternatives

Bio-based commercial or industrial goods are defined by the United States Department of Agriculture (USDA15) as:

“(A) composed, in whole or in significant part, of biological products, including renewable domestic agricultural materials, renewable chemicals, and forestry materials; or (B) an intermediate ingredient or feedstock”

In this section, we will analyse four bio-material - fungi, pineapple, cork and coffee ground, among fungi is bio-assemble material, pineapple and cork are bio-synthesis material and coffee ground is bio-fabricated ingredients material. Bio-assembled, bio-synthesis and bio-fabricated ingredients are subsets of bio-based material, however, bio-based material include animal products, so I narrow this definition down to bio-based leather alternatives.

Against real leather, just like people against fur, has a profound influence on ethical dimension in fashion industry. Animal rights organizations have taken the stance that no animal by-products should be used in manufacturing clothing and accessories.

However, just like with the leather industry, there are environmental concerns to consider with these alternatives.

Overall, the following alternatives are plastic-free, non-toxic. They use less water, they release less carbon, even absorb CO_2. As clothing, they have better functions such lightweight, waterproof, no dust absorbed and anti-microbial.

Bio-based Leather Alternatives- Fungi

The character of fungi leather：

- Lightweight.
- Waterproof.
- Fire-resistance.
- Non-toxic.
- No sewing involved.
- Trap more heat.
- Softer.
- Anti-microbial and suitable for sensitive skin.

Environmental impact:

- Mycelium plays “recycle role” in nature.
- Less water usage, 12 liters of water for a dress.
- Less carbon release
- None of the chemical substances and toxins.
- It can easily be composted.
- 100% biodegradable.

The disadvantages of fungi leather:

- Time-consuming and laborious.

Tech:

- Growing mycelium with natural fibers.
- Growing mycelium with knitted substrates.
- Growing mycelium with polymer spacer fabrics in different tightnesses.
- Growing mycelium in a 3D printed star shaped petri-dish.

Manufacture:

- Grow in lab.
- Only pasted and shaped on mold.

The role of fungi leather in fashion industry：

- As a whole piece of leather alternative.
- Break other natural fibers down.

Bio-based Leather Alternatives- Coffee Grounds

The character of coffee grounds leather：

- Odor control
- UV protection
- Eco-friendly
- Durability
- Water resistance

Tech:

- Surface texturing using 3D printing technology

Environmental impact:

- Coffee grounds sent to landfill emit methane gas
- Urban groundwater contains high levels of caffeine
- Coffee ground fiber is biodegradable and eco-friendly

The disadvantages of coffee grounds leather:

- Yet to be tested for true longevity
- Not widely produced
- Limited colors

Manufacture:

- Collecting coffee grounds
- Rinsing
- Drying
- Grinding
- Mixing other materials
- Dyeing with natural dyes
- Pour into moulds to make products

The role of coffee grounds leather in fashion industry：

- Apparel textile
- Footwear
- Home furnishings
- Athletic wear

Bio-based Leather Alternatives- Cork

The character of cork leather：

- A smooth, shiny finish
- Water resistant, flame resistant and hypoallergenic
- Durable
- Flexible and easy to maintain shape
- No dust absorption
- Lightness

Environmental impact:

- One of the most ecologically friendly materials available
- A highly renewable resource
- Stripped cork tree absorbs up to five times more CO2 than the unharvested ones

The disadvantages of cork leather:

- Torn and punctured more easily than real leather
- More susceptible to staining and tarnishes
- Difficult to repair

Manufacture:

- Harvesting the bark
- Dried for a total of six months
- Boiled
- Heat and pressure treatment
- Divided into leather-like fabric

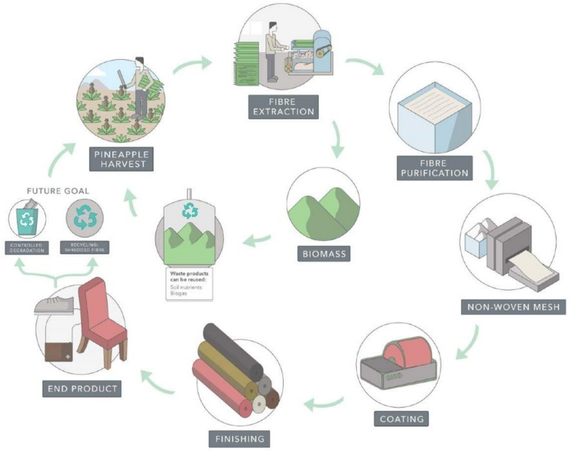
Tech:

- Heat to remove fungus and bacteria
- No chemicals in the whole process

The role of cork leather in fashion industry：

- Accessories like bags, keychain, purses, wallets
- Furniture
- Yoga mats
- Clothing
- Footwear

Bio-based Leather Alternatives- Pinatex



The character of Pinatex leather：

- Made from pinapple leaf fiber
- strength
- Durability

The disadvantages of Pinatex leather:

- Tansportation of materials will generate a certain amount of carbon emissions

Environmental Impact:

- Cradle to cradle
- No additional land, water, fertilizers, pesticides or other resources are needed for the production

Tech:

- GOTS certified pigments

Manufacture:

- Leaf collection
- Fiber extraction
- Washing&drying
- Purification
- Pinafelt
- Finising
- Pinatex

The role of Pinatex leather in fashion industry：

- Footwear
- Bag
- Furnishing
- Fashion

Manmade Recycled Synthetic

Over the last few decades there has been a major shift in the materials chosen by manufacturers, designers and consumers alike. Nowadays, a plethora of man-made synthetic materials dominate. The industry is awash with polyester, acrylic, nylon, polyester etc.

Whereas man-made synthetic are produced from petroleum, these materials are usually non-biodegradable. A non-biodegradable material can be defined as a substance that cannot be broken down by natural organisms and becomes a source of pollution. It largely destroys the environment - causing large amounts of chemicals, waste and carbon emissions.

With heightened awareness of the role fashion plays in the climate crisis, we have seen the fashion and other industries begin to recycle synthetic materials over the past few years. Compared to the use of virgin synthetic, manmade recyclable synthetics consume significantly less energy, have a lower carbon footprint and so on. From pre- production polyester waste to plastic bottles fished out of the ocean, multiple synthetic fibres can be broken down and given a new life as bio-plastic and recycled nylon. Both materials have better properties such as durability, flexibility and high elasticity.

Manmade Recycled Synthetic - Bio-plastic/Bio-synthetic

The character of bio-plastic/bio-synthetic:

- Diverse.
- Light-weighted
- Flexible.
- Elastic.
- Heat sensitive.

The feedstock of bio-plastic/bio-synthetic:

- 1st generation: Crops.
- 2nd generation: Waste.
- 3rd generation: Non food resources.

Environmental impact:

- Better performance on carbon emission and chemical usage than other synthetics do.
- Use CO_2 within the growing phase of the plant-based raw material.
- Biosynthetic fibers use natural renewable resources either wholly or partly.
- Biosynthetic have the potential to produce fewer greenhouse gases over their lifecycle.
- It still causes chemical usage in the manufacture process.
- Some non-biodegradable bioplastic will be landfilled or incinerated in the end of life.

Tech:

- Landfill Biodegradable Technology.
- Oxo-Degradable Technology.

The role of Bio-plastic in fashion industry:

- Footwear.
- Outwear.
- Carpets.
- Pantyhose.
- Sport-wear.
- Casual wear.

The Disadvantages of bio-plastic/bio-synthetic:

- Unique recycling system.
- Still maintain a high level of carbon emission.

Manmade Recycled Synthetic - Recycled Nylon

The character of recycled nylon:

- Durability
- Smooth and soft
- High elasticity

Environment impact:

- Eliminate discarded material and reduces greenhouse gas emissions from manufacturing
- Educed CO_2 emissions by 20% compared to virgin nylon fabrics

The Recycling Process:

- Collect plastic bottles, fishing nets, worn-out clothes or discarded carpeting that have been bought, used in the world and then trashed melted at high temperatures
- Melted at high temperatures
- The end product

The role of recycled nylon in fashion industry:

- Outwear.
- Sport-wear.
- Underwear
- Shoes

The Disadvantages of recycled nylon:

- Still not degradable
- Improper recycling process produces chemical pollution

Final Thoughts

To sum up, we represent three categories of bio-materials: planet-based material, bio-based leather alternatives and manmade recycled synthetic.

They have different duty in fashion industry, planet-based materials refer to more technologies, they are monuments on the transition towards a more sustainable ecosystem. Bio-based leather alternatives are focus on animals welfare, they aim to replace conventional animal leather products, so it more likes a commercial way. Manmade recycled synthetic has a crucial place in recycling industry.

In this area of fabric innovation, no such approach and technology is absolutely superior to the rest, but all the creative goals are consistent - to reject the use of non-renewable and cheap petroleum-based materials, and to ensure human and animal health and well-being.

THANK YOU!