

ACTAsia-The Researcher Team 2
Collaborative Challenge

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Introduction

Driven by the climate crisis and overproduction, industries will continue to shift to renewable and circular materials strategies in 2024. Companies will push forward progress on natural, renewable material sources and regenerative practices as solutions are sought that will actively improve nature's ecosystems rather than just do less harm. This report responds ACTAsia's Fur Free consumer education programme, which aim to raise consumers' awareness about the cost and consequence of wearing animal products, to human, animals and the environment. Animal product industry is massive and complex; thus, we only refer to animal product among fashion industry as background in this report. People always think that leather industry is an ancillary industry of meat industry. However, over-production and over-consumption always exists in fashion industry, it makes leather industry a real threat to the environment. As concluded in the World Economic Forum (WEF) Global Risks Report in 2020, the third largest threat to our global economy is climate threats and accelerated biodiversity loss. Additionally, killing, suffering and lack of compassion are well-known as unethical issue among fashion industry.

This report contained nine "challenger materials" that challenge the current unsustainable and unethical fashion system. The innovators and designers treat fabric as a partner, collaborate with them to maintain the wellbeing of the environment by reducing the release of toxic matters and GHGs, focusing on the lifecycle of the fabric and exploring innovative fiber technology. As Chapman Jonathan states that '[...] emerging field that recalibrates the parameters of 'good design' in an unsustainable age - prospecting, seeding and activating the power of design in creating social, economic and ecological resilience in an increasingly unstable world.' (Chapman, 2015: 8)

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Plant-based Material



Fig. 1. Katagu (2020)

Introduction

Plant-based material will not exacerbate soil erosion and water pollution caused by traditional farming. Plant-based materials are renewable and biodegradable. Plant-based material rivals conventional synthetic materials in strength and durability. 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—so you can look good and do good.



Fig. 2. Vollebak algae t-shirt (2022)

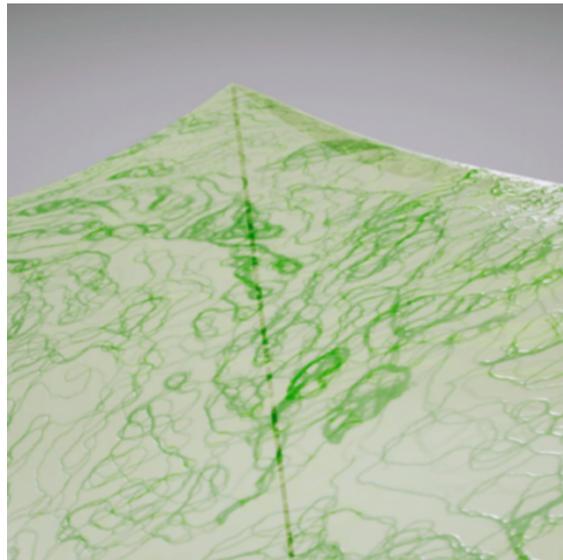


Fig. 3. Randa (2021)

Algae

1. One of the most adaptable vegan-based material which has good natural advantages.

As the original source of all plant life on the planet, Algae consumes carbon dioxide and produces up to 50%-80% of the oxygen on earth, so it has a great contribution to our environment and well-being. Algae materials are widely distributed and have good adaptability, which only needs light, carbon dioxide, and water, and it can grow at high speed, which colonies lakes in a day.

2. Multiple Values with Commercial Use

Materials are used in various fields, For example, it can be used in food and health, industrial applications, biofuel, bioplastic, pollution control and garment. For example, Aastha Poddar's KAAI project prints spirulina onto fabric via Indian block-printing as an

alternative to standard dyes.

3. Applying special manufacture kenya to the fashion industry (take vollebak algae t-shirt as example)

VOLLEBAX worked with Berlin-based algae pioneers Essi Johanna Glomb and Rasa Weber who recreated a technique used in Kenya to create algae cake. Instead of passing lake water through a cotton net, they pass water from the bioreactor through a filter. This process separates the algae, leaving a soupy algae paste. This paste is then dried in the sun to create a fine powder, and this powder is mixed with a water-based binder to make algae ink.

4. Algae is very environmentally friendly which reduces many carbon dioxide.

Algae organisms photosynthesizing CO₂ into oxygen, reducing material carbon footprint.

Brewed protein



Fig. 4. Brewed Protein Fiber. (2019)



Fig. 5. Brewed Protein Materials. (2020)

Introduction

Brewed Protein is a kind of protein materials produced from plant-based biomass using Spiber's proprietary fermentation process.

- 1. Brewed protein materials can be produced into a variety of forms.** Brewed protein is a 100% vegan material. It can be processed into different forms such as silk, cashmere, fur etc. It is strong, flexible, thin, lightweight and elastic, to the environment, it is 100% biodegradable.
- 2. It is manufactured ethically.** It is produced by plant-derived sugars as raw material. Spiber designs genes that code for the desired structural proteins. Microorganisms are then engineered to produce these proteins with high productivity using fermentation. The proteins are then separated from the liquid mixture containing the microorganisms. Dry purified protein.
- 3. Spiber's technology refers to Spiber's proprietary fermentation process,** during the manufacture process, it also refers to microbial fermentation technology.
- 4. Brewed protein can be designed as alternatives of many fashion elements,** such as fur and leather, cotton, polyester and resembling tortoiseshell or animal horn.
- 5. It is limited by cost and scale.** However, Spiber is now working on achieving mass production.
- 6. Spiber established an unique in-house manufacture process and ecosystem evaluation,** it leads less carbon emission. The raw material involves no petrochemicals. It doesn't create or break down into environmentally-persistent microplastics. It avoids something that happens when tiny fibers wash out during the process of doing laundry.

Organic Linen

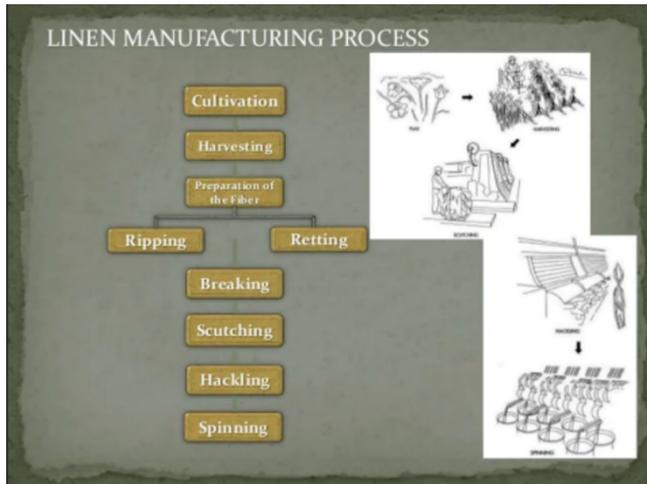


Fig. 6. Natural Fiber to Yarn Stage – Linen (2015)

Fig. 7. MagicLinen's clothing (2020)

1. The special features of organic linen

Organic linen is an antibacterial fabric, which means you don't need to wash it as often. Thanks to the temperature-regulating properties of organic linen, you can wear it comfortably all year round. And linen's fibers last longer than cotton, which makes it more expensive to produce, but it will last longer in your wardrobe.

2. The organic linen production process

To extract the fibers, the Organic flax are either cut or pulled by hand from the ground (it's said that pulling creates finer linen). The seeds are then removed through a process called winnowing or ripping, followed by retting which removes the plant stock from the fibers. Once the fibers are separated to collect the longest pieces, which can be up to 20 centimeters long, they are then spun into yarn.

3. Biodegradable and stylish fabrics

Organic linen is one of the most biodegradable and stylish fabrics in fashion history. It is strong, naturally moth resistant, and made from organic flax plant fibers, so when untreated (i.e., not dyed) it is fully biodegradable. Its natural colors include ivory, ecru, tan, and grey.

4. How Sustainable is Organic Linen?

One of the flax plant benefits is that it traps huge amounts of carbon dioxide from the environment. One hectare of flax retains 3.7 tons of CO₂ every year. Naturally, this plant produces optimal soil quality, which helps to increase the returns on the following crops. Flax preserves land and requires minimal water to grow. It helps to protect water resources as rainwater is sufficient for its growth. Therefore, it doesn't require irrigation.

5. Limitations of organic flax

Organic linen is often regarded as a luxury fabric by modern consumers. The cost of it can be traced to its production. In particular, it is known that organic flax is more difficult to spin than other fabrics. This slows down production and minimizes yields.

In addition, organic linen comes from flax that has been grown without any chemical inputs and using farming methods that encourage biodiversity, so it is highly sustainable. Only 1% of linen is farmed organically, so organic linen is a very rare fiber. Because of this relative scarcity, prices for organic linen tend to go up.

6. Applications of organic linen

Organic linen is a versatile material, and

brands use it for fashion fabrics, home fabrics, and even canvas. Manufacturers use this fabric for products such as clothes, underwear, curtains, tablecloths, window treatments, bed sheets, towels, and upholstery. In addition, linen also proves a popular fabric for clothing brands' summer collections because it is lightweight and absorbs moisture from the body, helping the body stay cool.

7. A brand that uses organic linen

This image from MagicLinen's clothing, which is handmade from beautiful and sustainable 100% organic linen fabric that is both practical and chic. All of the items are stone-washed for maximum softness, and the designs are effortless and stylish made to stand the test of time.

Comparison between algae, brewed protein, and linen

Plant-based material compared

	Characteristics	Manufacture	The role in fashion industry	Tech	Environmental impact	The disadvantages of fungi leather
Brewed Protein	<ol style="list-style-type: none"> Totally vegan Diversity of forms. Soft and warm as cashmere Ethically manufacture, and nit is 100% biodegradable 	<ol style="list-style-type: none"> Using plant-derived sugars Designs genes Microorganisms are engineered to produce these proteins Separate proteins Dry purified protein 	<ol style="list-style-type: none"> Fur and leather alternatives Resembling tortoiseshell or animal Cotton and polyester alternatives 	<ol style="list-style-type: none"> Spiber's proprietary fermentation process Microbial fermentation technology 	<ol style="list-style-type: none"> In-house technology leads to no carbon emissions. No involving petrochemicals 	<ol style="list-style-type: none"> The cost is high No big scale yet
Organic linen	<ol style="list-style-type: none"> Durable Resilient Comfort Air permeability Easy washing Better structural properties 	<ol style="list-style-type: none"> Cultivation Harvesting Preparation of the Fiber Ripping/ Retting Breaking Scutching 	<ol style="list-style-type: none"> Home furnishings Apparel textile Footwear Accessory 	<ol style="list-style-type: none"> Separation of fibre from woody stems using the "Retting/Rapping" technique Textile Technology 	<ol style="list-style-type: none"> Most biodegradable Organic flax production requires 80% less energy Minimal water consumption during growth 	<ol style="list-style-type: none"> More difficult to spin than other fabrics Organic flax accounts for only 1% of the flax produced and is therefore a very rare Expensive
Algae	<ol style="list-style-type: none"> The diversity of the habitats Good adaptability Nature advantage 	<ol style="list-style-type: none"> Grow algae in bioreactors Separate the algae Print the algar onto T-shirt 	<ol style="list-style-type: none"> T-shirt Bio-plastic Pollution control 	<ol style="list-style-type: none"> Berlin-based algae pioneers Essi Johanna Glomb and Rasa Weber who recreated a technique used in Kenya to create algae cake 	<ol style="list-style-type: none"> New research finds that adding seaweed to beef cow diets can reduce their methane emissions by as much as 82 percent, reports Oliver Milman for the Guardian. 	<ol style="list-style-type: none"> Some algae may be harmful to humanity

Algae, brewed protein, and organic linen are all biodegradable and environmentally friendly, which eliminates Carbon dioxide emissions and chemical product releases. Each material has its own unique advantages and characteristics. For example, the biggest feature of brewed protein can be brewed protein materials can be processed into a variety form, with examples ranging from delicate filament fibers with a silky sheen to spun yarns that boast features such as cashmere-like softness or the renowned thermal and moisture-wicking properties of wool. The biggest feature of Algae is its good adaptability, which only needs light, carbon dioxide, and water to grow, so it can grow normally even in the laboratory, reducing the occupation of additional land resources. And organic linen is strong, breathable and hypoallergenic fiber, which is one of the most biodegradable and stylish in fashion in history. These plant materials have been widely used in the fashion industry, such as home furnishing, footwear, and accessories. At the same time, these materials also have disadvantages such as high price and complicated processing.

Bio-based Leather Alternatives

Introduction

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 CO₂. As clothing, they have better functions such lightweight, waterproof, no dust absorbed and anti-microbial.

Fungi Leather



Fig. 8. MycoTEX dress. (2016)



Fig. 9. MycoTex Fabric. (2016)

1. **Fungi leather is a next-to-skin leather.** It is lightweight, softer, waterproof, fire-resistance, non-toxic and antimicrobial.
2. **Designers bend mycelium with different fibers,** such as natural fibers, knitted substrates and polymer spacer fabrics.
3. **Fungi leather grow in lab,** it is only processed by pasting and shaping on mold.
4. **Fungi leather used as alternatives, in natural system, it plays the role of recycling.** Fungi leather designed as a whole piece of leather alternatives. It breaks other natural fibers down.
5. **The limitations of fungi leather is time-consuming and laborious.**
6. **The bad environmental impact of fungi leather is not-known currently.** mycelium plays “recycle role” in nature. It refers to less water usage and less carbon release, it only use 12 liters of water for a dress. None of the chemical substances and toxins. It can easily be composted and 100% biodegradable.

Coffee Grounds Leather



Fig. 10. S.café's yarn (2015)



Fig. 11. Textiles made from coffee grounds (2021)

1. Characteristics which are also its strengths

One of the natural properties of coffee grounds is that they help to eliminate odors - which is good news for anyone familiar with the smell of old trainers. Of course, it is also waterproof, durable, sustainable and lightweight, making it a great alternative to leather.

2. Beneficial effects on the environment

Most coffee grounds are discarded into the environment as waste and recycling would be beneficial to the environment. The manufacturing process of coffee fibers involves the use of chemicals that are non-toxic in nature, so they do not pose a risk to the environment. The manufacturing of the new product does not require high temperatures for carbonization, making it a more efficient process. More importantly, the process also does not use dangerous chemicals.

The coffee fibers manufactured by S.café are environmentally friendly textiles, as they are 100% biodegradable and have no impact on the environment.

3. A threat to the environment and wildlife

When coffee grounds decompose in landfills, they release methane gas, which has a greenhouse effect 28 times greater than that of carbon dioxide. And it turns out that our bodies don't absorb all the caffeine we consume. Some of it is excreted in our urine and ends up in the sewage system or in the environment, posing a threat to wildlife.

4. A wide range of uses in the fashion industry

Coffee yarns made from coffee grounds are versatile and can be used in a variety of products, from outdoor and sports performance clothing to household items for everyday use.

A flexible biomaterial called Tômtex is a textile made by mixing discarded seafood shells with coffee grounds. It can be made into accessories such as card cases, wallets and key fobs

5. Tômtex - Textiles made from coffee grounds

Tômtex, a flexible biomaterial

developed by Vietnamese designer Uyen Tran, is a textile made from discarded seafood shells mixed with coffee grounds. This biodegradable material is durable, yet soft enough to be hand-sewn or machine-stitched.

Crucially, instead of letting the material cure in perfectly smooth moulds, the

designer makes her own pieces in clay or using a 3D printing process. This allows her to create her own finishes, able to mimic the look of snakeskin or crocodile skin as well as more abstract embellishments. It is also possible to replicate any textured surface, so the pattern design possibilities are endless.

Cork Leather



Fig. 12. Ovide's leather jacket (2018)

1. Characteristics of cork leather

Cork leather has a smooth, shiny finish, an appearance which improves over time. It is water resistant, flame resistant and hypoallergenic. Fifty per cent of the volume of cork is air and consequently products made from cork leather are lighter than their leather counterparts. The high friction coefficient of cork means that it is durable in situations where there is regular rubbing and abrasion. The elasticity of cork guarantees that a cork leather article will retain its shape and because it does not absorb dust it will remain clean.

2. One of the most ecologically friendly materials

The bark of the Oak tree is a highly renewable resource as it can be harvested over and over again several times. The tree does not get harmed by this process. It even is a beneficial process for the tree, since a stripped cork tree absorbs up to five times more CO₂ than the unharvested ones.

3. No chemicals in the whole process

After harvesting the bark from the cork

tree, this recyclable, natural product made in Europe is dried for a total of six months, then boiled and after that goes through a heat and pressure treatment before it is divided into leather-like fabric. The fabric is later attached onto a cotton backing.

4. Disadvantages of cork leather

Cork leather tears and punctures more easily than leather. It is also more likely to stain and lose its luster if it is not adequately protected. Although its natural appearance can be beneficial in some cases to hide damage, it can be difficult to repair.

5. Applications in the fashion industry

The product lines made from cork leather are endless, from accessories such as bags, keychains, wallets and purses to furniture, wall coverings and even yoga mats! Marc Jacobs, Gucci, Calvin Klein and many other luxury brands have launched collections made from cork.

6. A brand that uses cork leather

The leather jacket in the picture is from the fashion brand Ovide, a zero-cruelty brand who use textiles that are healthy alternatives to leather and also do not contain any animal derivatives or toxic

chemicals. Thanks to these innovative materials, they are effective in combating CO2 production and deforestation.

Pinatex



Fig. 13. Pineapple leaf recycling process (2018)



Fig. 14. Boss vegan shoes (2020)

1. Biobased leather alternatives, which is from “Cradle to Cradle”
Pinatex® is made of fibers from the waste leaves of the pineapple plant. These leaves are a by-product from existing pineapple harvest, so the raw material requires no additional

environmental resources to produce. From initial sampling to developing a viable supply chain, the Pinatex® journey is inspired by the principles of a Circular Economy and Cradle to Cradle values.

2. Multiple applications in fashion industry

More and more brands are getting aware of this ongoing trend of sustainability. They understand the need for more sustainable options and starting to offer many alternatives to leather. Since Pinatex is so versatile it can be used for almost any piece of fashion starting from small watch straps to big jackets.

3. Use special manufacturing processes to provide Pinatex additional strength, durability and water resistance

Decortication is the process called when the cellulose fibres of the leaves get extracted. This process still takes place at the farm in order to further reduce CO2 emissions. And the biomass left over after removing the fibre is not wasted either. It is a very nutrient rich natural fertiliser for the soil. It basically gets used as a biofuel. Then the extracted fibers now get washed and

dried. Thereafter, the fibers become a non-woven mesh by stinging thousands of needles into the fibers in an industrial, mechanical process to produce a felt-like structure.

4. Compared to animal leather or synthetic leather (i.e PU leather) pineapple leather is way more sustainable and eco friendly

During the manufacturing process of conventional leather called tanning over 250 different toxic heavy metals and chemicals are used such as aldehyde, cyanide and lead. These substances are very harmful to the health of workers as well as the environment. Pinatex® uses no heavy metals, chemicals or toxic substances that could potentially harm the environment, animals or the people that process it. And it takes way less water and other resources and the overall environmental impact is way better.

Comparison between fungi leather, coffee grounds leather, cork leather and Pinatex

Bio-based leather alternatives compared

	Characteristics	Manufacture	The role in fashion industry	Tech	Environmental impact	The disadvantages of fungi leather
Fungi	<ol style="list-style-type: none"> 1. Lightweight 2. Waterproof 3. Non-toxic 4. No sewing 5. Sofer 6. Trap more heat 7. Anti-microbial 	<ol style="list-style-type: none"> 1. Grow in lab 2. Only pasted and shaped on mold 	<ol style="list-style-type: none"> 1. As a whole piece of leather alternative 2. Break other natural fibers down 	<ol style="list-style-type: none"> 1. Growing with natural fibers 2. Growing with polymer spacer fabrics 3. Growing with 3D printed shaped petri-dish 	<ol style="list-style-type: none"> 1. Less water usage 2. Less carbon release 3. None of the chemical substances and toxins 	<ol style="list-style-type: none"> 1. Time-consuming and laborious
Cork	<ol style="list-style-type: none"> 1. A smooth, shiny finish 2. Water resistant, flame resistant 3. Durable 4. Flexible 5. No dust absorption 6. Lightweight 	<ol style="list-style-type: none"> 1. Harvesting the bark 2. Dried for a total of six months 3. Boiled 	<ol style="list-style-type: none"> 1. Accessories like bags, key-chain, purses, wallets 2. Furniture 3. Yoga mats 	<ol style="list-style-type: none"> 1. Heat to remove fungus and bacteria 2. No chemicals in the whole process 	<ol style="list-style-type: none"> 1. One of the most ecologically friendly materials 2. A highly renewable resource 3. Stripped cork tree absorbs up to more CO2 	<ol style="list-style-type: none"> 1. Torn and punctured more easily than real leather 2. More susceptible to staining and tarnishes 3. Difficult to repair
Pinatex	<ol style="list-style-type: none"> 1. Made from pineapple leaf fiber 	<ol style="list-style-type: none"> 1. Leaf collection 2. Fiber extraction 3. Washing&drying 4. Purification 5. Pinafelt 6. Finishing 7. Pinatex 	<ol style="list-style-type: none"> 1. Footwear 2. Bag 3. Furnishing 4. Fashion 	<ol style="list-style-type: none"> 1. GOTS certified pigments 	<ol style="list-style-type: none"> 1. No additional land, water, fertilizers, pesticides or other resources are needed for the production 	<ol style="list-style-type: none"> 1. Ransportation of materials will generate a certain amount of carbon emissions
Coffee grounds	<ol style="list-style-type: none"> 1. Odor control 2. UV protection 3. Eco-friendly 4. Durability 5. Water resistance 	<ol style="list-style-type: none"> 1. Collecting coffee grounds 2. Rinsing, Drying, Grinding 3. Mixing other materials 4. Dyeing with natural dyes 5. Pour into moulds to make products 	<ol style="list-style-type: none"> 1. Apparel textile 2. Footwear 3. Home furnishings 4. Athletic wear 	<ol style="list-style-type: none"> 1. Surface texturing using 3D printing technology 	<ol style="list-style-type: none"> 1. Coffee grounds sent to landfill emit methane gas 2. Urban groundwater contains high levels of caffeine 3. Coffee ground fiber is biodegradable and eco-friendly 	<ol style="list-style-type: none"> 1. Yet to be tested for true longevity 2. Not widely produced 3. Limited colors

It's easy to imagine that in the near-future, leather industry will no longer carry the controversial reputation thanks to these innovative founding. However, we still need to be conscious of the environment when gazing these innovations.

To human, above these leather alternatives cover the most of leather products in daily life, like garments, accessories, bags and footwear, also they have great function and durability. It seems like there is no need to worry about the 'leather' demand in daily life. However, the price of these products will impact consumers' choices a lot, even it is rational to set a high price due to the technology and costing during processing these products. Even for these sustainable fibers, there is no way to thoroughly understanding the impact of chemical usage, chemical usage impact always is an uncertainty in fashion industry. For the coffee grounds leather, the high levels of caffeine containing in the urban groundwater is still a big issue among the manufacture process.

To animals, there are more people paying attention on animal welfare, including treating animals with respect and compassion. Leather will no longer be the by-product of meat industry.

To the environment, most of bio-based leather alternatives have a better performance on water usage, chemical usage and carbon emissions. What they can do better is processing raw materials and reducing carbon emission during the transportation.

Manmade Recycled Synthetic

Introduction

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 etc.

Whereas man-made synthetic is 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 fibers can be broken down and given a new life as r PET, ECONYL® or Spanflex.

Both materials have better properties such as durability, flexibility and high elasticity.

Bio-plastic/Bio-synthetic



Fig. 15. A petroleum-free dress (2021)

Introduction

A polymer created from either partial or 100% natural renewable resources for the manufacture into synthetic fibers.

1. **Bio-plastic is a great alternative of conventional plastic and polyester, which with many practical characters**, such as light-weighted, flexible, elastic and heat sensitive.
2. **The feedstock of bio-plastic has been through 3 generation:** 1st generation: Crops. 2nd generation: Waste. 3rd generation: Nonfood resources.
3. **The technology of bio-plastic refer to landfill biodegradable technology and oxo-degradable technology.**
4. **Bio-plastic can be used as fabric of some type of garments**, like footwear, outwear, carpets, pantyhose, sport-wear and casual wear.
5. **Bio-plastic as a recycled material, it still refers to some sustainable limitations.** Bio-plastic requires an unique recycling system. The manufacture process of bio-plastic still maintain a high level of carbon emission.
6. **However, bio-plastic is still important to the whole ecosystem.** It has a better performance on carbon emission and chemical usage than other synthetics do. It uses CO₂

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 bio-plastic will be landfilled or incinerated in the end of life.

Recycled Nylon



Fig. 16. Minlan fabric made with recycled nylon (2017)



Fig. 17. Patagonia jacket made with recycled nylon (2021)

1. Alternative to nylon material—— recycled nylon

Nylon is one of the strongest plastics we use in our products. When we need a super lightweight fabric, nylon is vital for its strength. But nylon is a petroleum-based material, and producing it has a high cost in energy and greenhouse gases. Incorporating as much recycled nylon as we can lessens our dependence on virgin petroleum as a raw material source, helps eliminate discarded material and reduces greenhouse gas emissions from manufacturing. Using recycled nylon also promotes new recycling streams for nylon products that are no longer functional.

2. Recycled nylon in Fashion Industry

Recycled nylon is a versatile fibre working across diverse product categories including lingerie and

intimates. Brooklyn-based brand Daisy & Elizabeth is dedicated to maintaining a low carbon footprint by using recycled nylon lace in lingerie. Guangzhou Tianhai Lace is a key supplier of GRS-certified recycled nylon. This vertically integrated mill focuses on recovering nylon that would otherwise be cast off and mixes it with recycled polyester and modal for an optimum sustainable product.

3. The major environmental impact of the recycled nylon

recycled nylon is mainly made from postindustrial waste fiber and discards from weaving mills and postconsumer fishing net, which helps eliminate discarded material and reduces greenhouse gas emissions from manufacturing

Comparison between bio-plastic/bio-synthetic and recycled nylon

Manmade recyclable synthesis

	The character of fungi leather	Manufacture	The role in fashion industry	Tech	Environmental impact	The disadvantages of fungi leather
Bio-plastic/ Bio-synthetic	1. Diverse 2. Light-weighted 3. Flexible 4. Elastic 5. Heat sensitive	1. 1st generation :Crops 2. 2nd generation: Waste 3. 3rd generation: Non food resources	1. Footwear 2. Outwear 3. Carpets 4. Pantyhose 5. Sport-wear 6. Casual wear	1. Landfill Biodegradable Technology. 2. Oxo-Degradable Technology	1. Better performance on carbon emission and chemical usage than other synthetics do 2. Use CO2 within the growing phase of the plant-based raw material	1. Unique recycling system 2. Still maintain a high level of carbon emission
Recycled nylon	1. Durability 2. Smooth and soft 3. high elasticity	1. Recycling, which comes from nylon carpets, tights, etc.	1. Shoes 2. Outdoor jacket	1.Q-NOVA® utilises the innovative MCS process(such as Q-NOVA)	1. It reduces the global warming impact of nylon by up to 90% compared with the material from oil	1. High price

Although bio-plastic/bio-synthetic and recycled nylon are synthetic materials derived from waste plastics and are still a man-made material that does not biodegrade. However, these recyclable alternatives have been developed from plastics that already exist in the world and help turn waste into something useful. As an added benefit, producing recycled materials requires less energy than virgin fibres. This can be less energy intensive if deployed in the right way, for example by sourcing waste from both landfill and the sea.

In addition, the selective use of recycled synthetic materials helps to extend the life of garments, durability and provide support properties for our more technical pieces. However, these materials are by no means the perfect solution and even recycled plastic alternatives have their drawbacks. All plastic materials shed microfibres and tiny plastic particles can pollute the environment and waterways when washed. These are all things that manmade recyclable synthesis cannot avoid.

Collaboration for a better future

To sum up, this report demonstrated 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 animal 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.

Many development approaches for plant-based materials have been tried, but not all materials are commercially scalable, only some can be applied, and many biomaterials are still in the experimental stage. Brands must test market reactions to gain a competitive edge in sustainable innovation.

It is clear that vegan plant based alternative materials have a bright future and they have already attracted a lot of attention from designers and companies around the world. However, despite the perceived suitability and availability of vegan plant based alternative materials, research and development is not over, as continued efforts are needed to ensure a bright, long-term future for the materials. Moreover, as people become increasingly aware of the importance of adopting more sustainable practices in the fashion industry, it is hoped that reliance on animal leather and non-renewable materials will diminish.

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