PROFESSIONAL PROJECT

BACHELOR OF DESIGN
(TEXTILE DESIGN)

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https://youtu.be/bcTzyx35odY

3D Printing

3D printing is the form of additive manufacturing in which components are is fabricated in additive fashion by adding the successive layers of materials together.
It is also known as:

Rapid Prototyping
Additive Manufacturing

It is the process of making the 3D object from a digital file, here object is created by laying down successive layers of materials until the entire object is created.

3D printing methods possess several benefits over traditional manufacturing, including cost-effectiveness, time, resource, and energy savings, significantly less material waste, and enhanced design freedom. Several industries including manufacturing, aerospace, transportation, the space industry, and construction have extensively explored the use of these methods and widely implemented 3D printing technologies.
There have been several different types of 3D printing processes developed over the past few decades, including fused deposition modeling, stereolithography, selective laser sintering, selective laser melting, digital light processing, and fused filament fabrication.

https://youtu.be/ZPN_YQEfCRU

3D Printing in Textile Industry

Although the field of 3D printing fabrics is still in its infancy, there are some significant advantages that producing textiles using these methods could bring. The textile industry consumes a large amount of water and material resources, leaving a large environmental footprint. Currently, the global textiles industry is extremely unsustainable, and scientists are constantly looking for new ways to improve industry methods.

3D textile printing has the potential to significantly reduce the number of resources required to produce fabrics for applications such as clothing and furniture. Using 3D printing methods, processes can be streamlined, less raw materials, chemicals, and water are used, and the amount of waste materials produced is significantly reduced.

Other advantages include lower energy requirements and, as a result, lower carbon emissions, cost savings, and increased design freedom. Multi-material printing enables advanced, innovative material design that is not possible with traditional manufacturing techniques.

Another important innovation enabled by 3D printing is the creation of "smart" materials with embedded functionalities and unique structures. In summary, 3D printing is a game-changing solution for the textile industry.

What is 3D printing in Fashion

3D printing in fashion is an exciting new direction for fashion designers and artists who want to create wearable art and intricate geometric designs. 3D printed wearable clothing, on the other hand, is not currently intended to be worn on a daily basis. Modern designs are primarily limited to butterfly-inspired haute couture, jewellery, and art pieces.

Designers use 3D printers to create their unique patterns when creating this type of fashion. They only print as much of the product as is required. This manufacturing process allows them to reduce waste material for each garment, ensuring that their creation has no negative environmental impact.

The Rise of 3D Printing in Fashion

The advantages and benefits of 3D technology are causing fashion designers to sit up and take notice, resulting in a significant increase in interest and awareness. As a result, 3D printing is being used across the fashion spectrum.

Emerging 3D fashion creations have been spotted on the runways of high-end fashion shows, as well as in more low-cost brands. Similarly, new techniques and innovations for 3D printed fashion are constantly being developed.

In terms of becoming more mainstream, the 3-dimensional fashion trend is still growing. However, fashion experts predict that this is about to change, and that 3D printed fashion will grow significantly in the near future.

n41.com/the-rise-of-3d-printing-in-fashion/

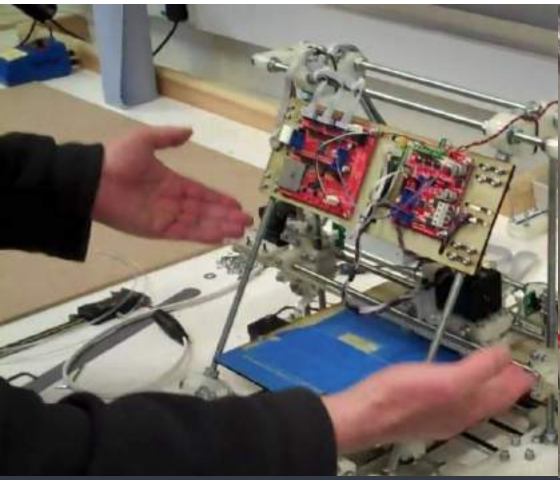
https://medium.com/@stitchdiary/what-is-3-d-textile-printing-12f29b59bc76

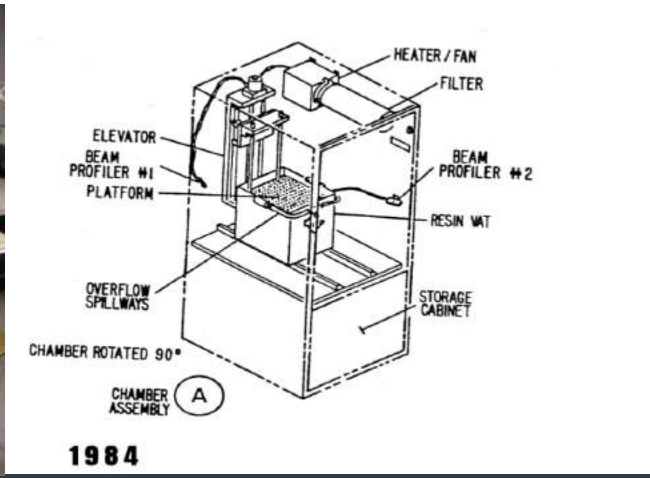
History

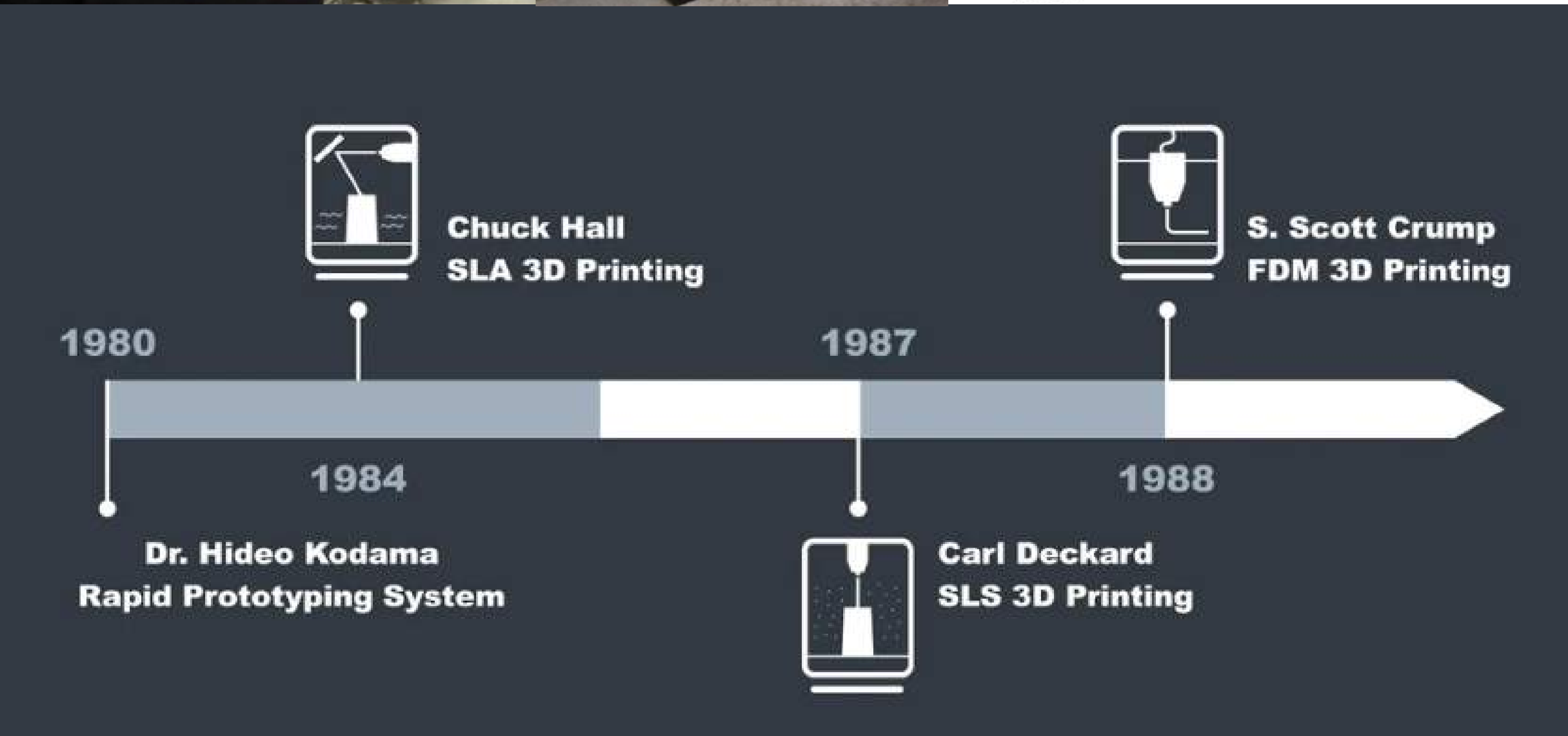
This technique has been used for over 30 years. The first 3D printing patent was granted in 1986 to an American, Chuck Hull, founder of 3D Systems, for Stereolithography Apparatus. Around the same time, the Massachusetts Institute of Technology (MIT) coined the term 3D printing in reference to their ongoing research into the technology.

Hideo Kodama's early work in laser cured resin rapid prototyping was completed in 1981, building on Ralf Baker's work in the 1920s for making decorative articles (patent US423647A). His invention was further developed over the next three decades, culminating in the introduction of stereolithography in 1984.

In 1987, Chuck Hull of 3D Systems invented the first 3D printer, which used stereolithography. This was followed by innovations such as selective laser sintering and selective laser melting. Other expensive 3D printing systems were developed in the 1990s and 2000s, but their prices dropped dramatically when the patents expired in 2009, making the technology available to a wider range of users.







How 3D printing work

A replica of an item is created on the computer by designing softwares. The CAD information is sent to the printer. The printer forms the item by depositing the materials in layers, Starting from the bottom layers on the platform. In some cases light or lasers are used to harden the materials.

General Principles

Modeling

Making the Blueprints on the computer and Slice them into digital cross sections to act as a guidelines for the printing

Printing

The machine read the design and lays down successive layers of liquid powder or sheet materials to build the model from a series of cross sections these layers which cross ponds to virtual cross-section form a CAD machine are joined together or automatically fused to create the final shape the primary advantage of this thickness is its ability to create almost any shape or geometrical feature.

Finishing

Although the printed product resolution is sufficient for many applications, printing a slightly over-sized version of the described size and removing materials which is a subtractive process can be helpful for the perfect size and perfect finish.

Advantages of 3D Printing

In the traditional system how much we are efficient but wastage of material is inevitable but in 3-D printing we require only the material which will get printed as raw so there is no wastage of raw material in 3-D printing we can print exact shape and size of the garment we require.

Beyond zero wastage 3-D printing eliminates labour intensive process because it is done in automated manner by machines so it reduce labour cost to a great extend.

3-D printing also has a big advantage for the improved quality because there is no chances of human error in 3-D printing, so we can print exact shape and size of the materials we required and human error is completely eliminated from the manufacturing process.

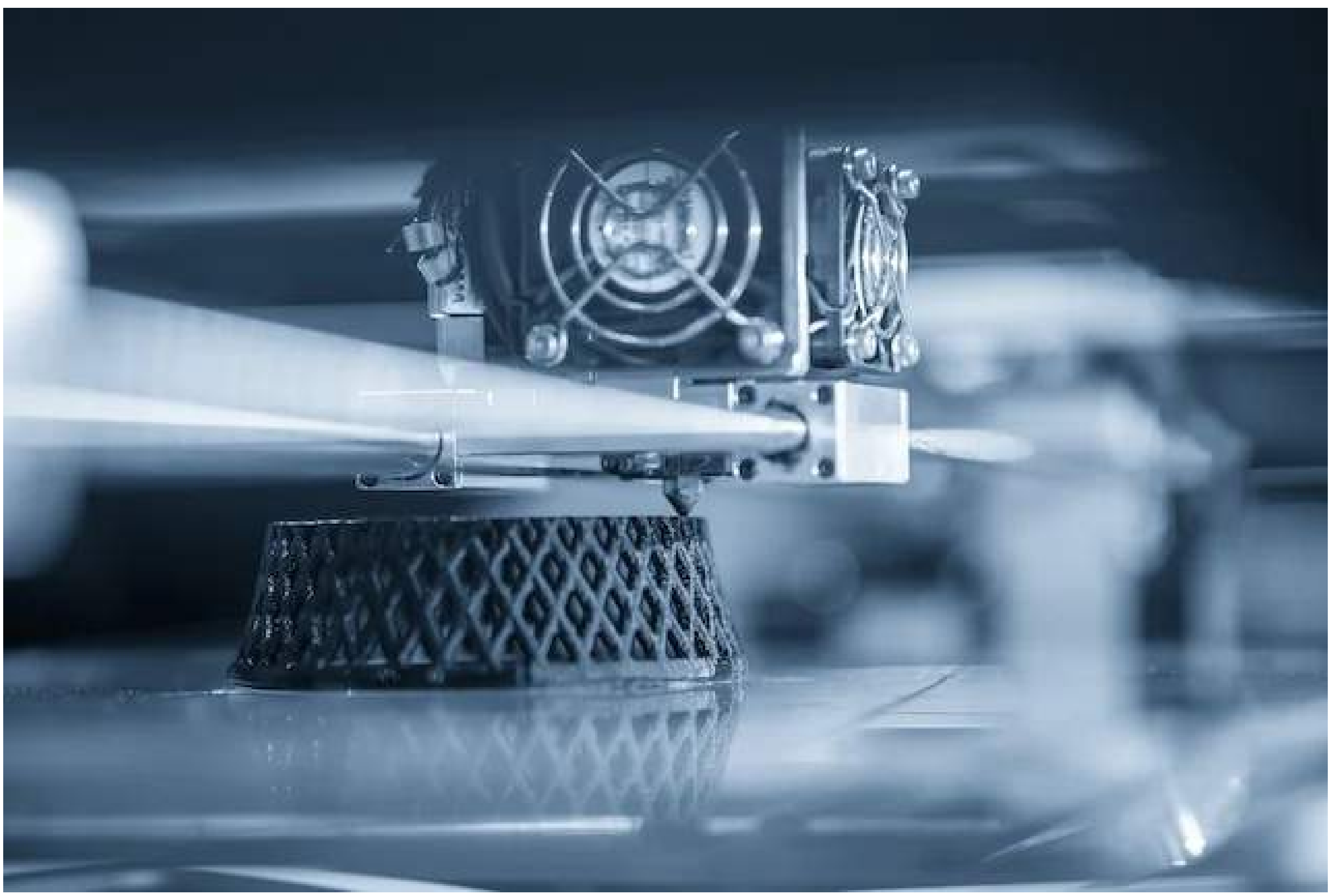
Disadvantages of 3D Printing

When it comes to 3D printed textiles, we still have a long way to go. Currently, 3D printed textiles and garments do not provide the comfort and flexibility that one would expect from a garment. They do not absorb moisture because the raw material layers fuse together, leaving no air gaps.
Aside from material issues in 3D printing, more research is required to understand how design elements can impart drapability and breathability into 3D printed garments, thereby making them wearable.
Furthermore, unlike traditional manufacturing, 3D printed textiles cannot be sewn into garments. Alternatives, such as melting edges and fusing them to other panels, are being investigated, but it is still in the early stages.
Finally, the material cost for 3D printing textiles and garments is high. While producing samples and limited pieces may be feasible, identifying materials that can make the process commercially viable remains a challenge.

https://medium.com/@stitchdiary/what-is-3-d-textile-printing-12f29b59bc76

Future of 3D Printing

Although it is still in the conceptual stages of using this technology in fashion, we can be optimistic that it will change the game for future retailers. 3D printing has the potential to eliminate the need for a lengthy manufacturing process in both high-end and mass-market fashion retail.
It still need to overcome the challenge of locating suitable materials. Although flexible polymers are being investigated for this purpose, the industry requires a broader range of raw materials that can be 3D printed into comfortable and wearable garments.
Another significant challenge is the development of specialised 3D printers that can print wearable fabrics and are suitable for garments.
Overall, it may still take a few years, if not a decade, to get there, but 3D printing has the potential to change the business altogether.

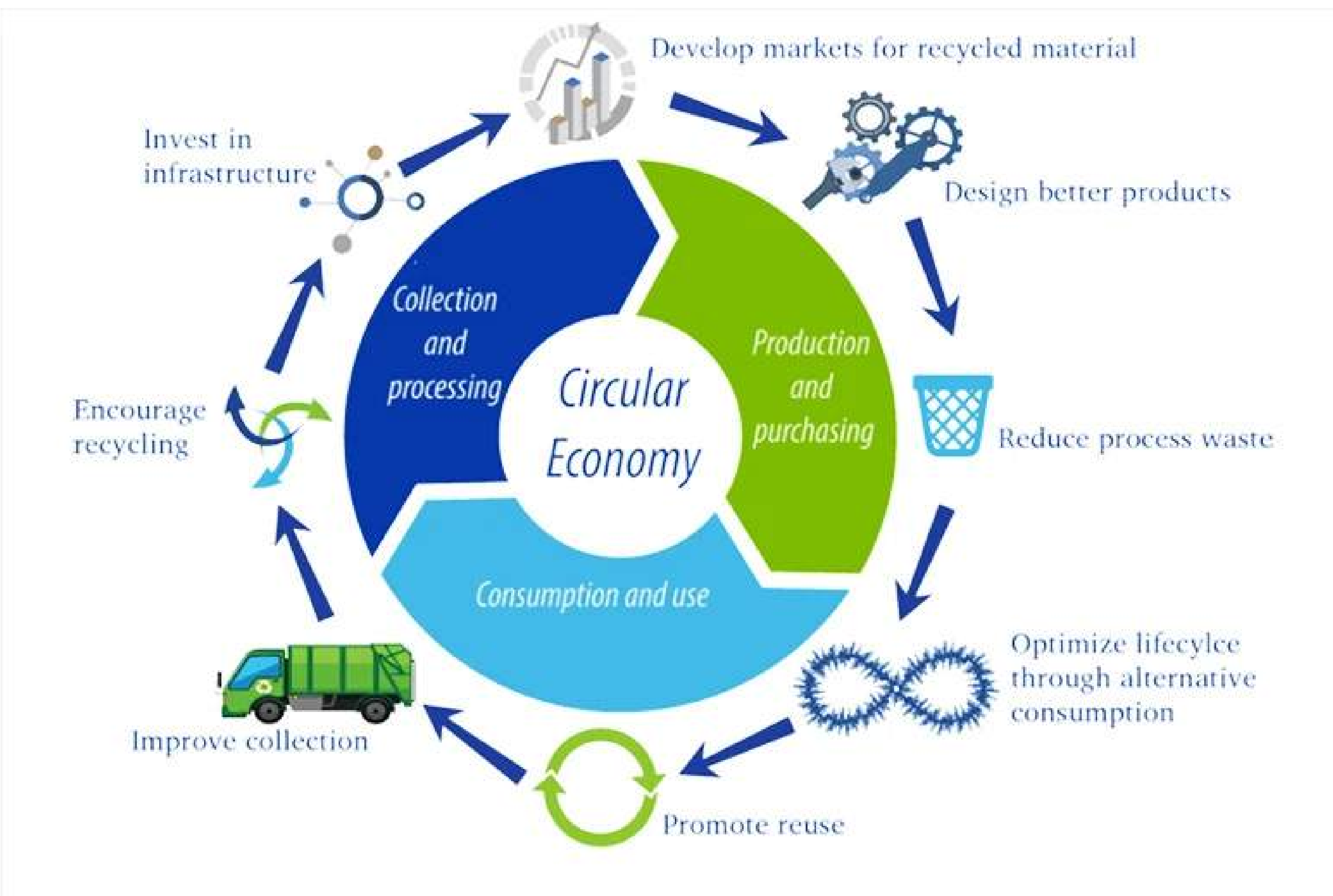


https://medium.com/@stitchdiary/what-is-3-d-textile-printing-12f29b59bc76

3D Work in Fashion and Sustainability

One of our generation's battles is choosing the appropriate materials to produce in a more environmentally friendly manner. Fashion is under pressure to keep producing new clothes season after season.
Fast fashion is one of today's problems, so everyone's attention is now focused on reducing the industry's impact. 3D printing is a viable solution because it allows for material waste reduction and the use of recycled materials.
There is clearly an evolution in the way we think about fashion and clothing manufacturing. New factors are now being considered, and the reasons why designers choose 3D printing are changing, it is becoming increasingly important to use 3D printing for sustainable and eco-friendly purposes.
Textiles, for example, contribute to the global waste problem, which is why many aspects of the manufacturing process must be rethought in order to be more environmentally friendly. Using 3D printing reduces waste because it only need the amount of material needed to complete your project.

It is also a method of utilising some recycled materials in the manufacturing process. Adidas developed a 3D printed midsole for one of its sneakers using recycled plastic from the ocean. Creating new materials and using plastic in a more responsible manner are new reasons for fashion companies, including big brands like Adidas, to use 3D printing.



https://www.sculpteo.com/en/3d-learning-hub/applications-of-3d-printing/3d-printed-clothes/

Projection on 3D Printing

NASA’s Scale Maille Project

Materials that can withstand the rigours of extreme environments are required in the field of space exploration. NASA, which is on the cutting edge of 3D printing technology, has sought to develop fabrics that provide enhanced insulation and protection against the harsh environment of outer space. NASA is working on developing "scale maille," which can be printed in one piece from innovative flexible metal. It is similar to scale armour and has improved thermal control, flexibility, foldability, and strength. Geometry and function can both be printed, prompting NASA scientists to coin the term "4D printing."

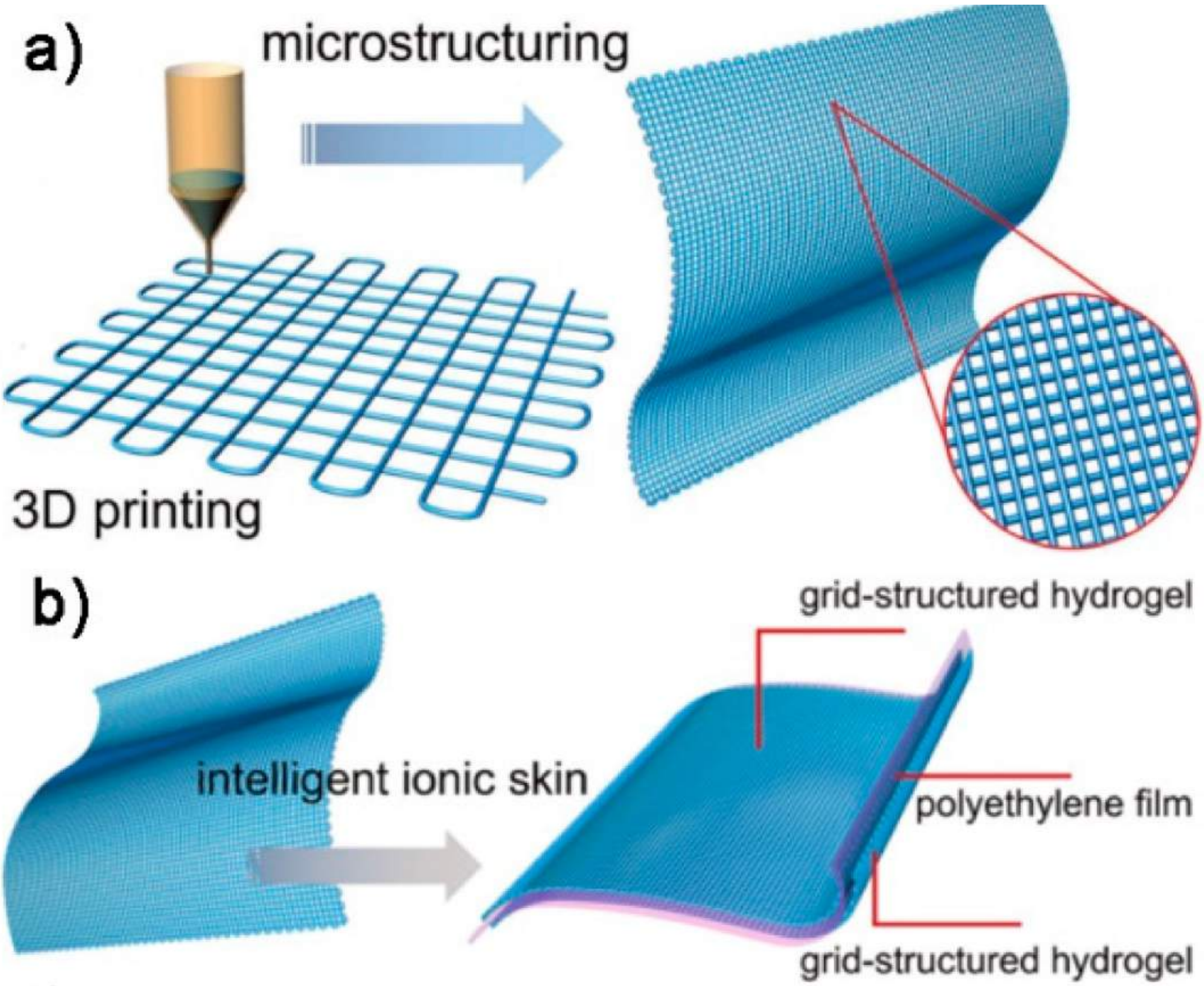
The Spider Dress

Anouk Wipprecht's The Spider Dress has mechanical arms that extend and retract as a response to external stimuli when people approach. The wearer's own breath will help to signal the defense posture of the robotic arms. The dress is fully 3D printed with the Selective Laser Sintering technology.

https://www.sculpteo.com/en/3d-learning-hub/applications-of-3d-printing/3d-printed-clothes/

3D Printed Electronic Materials

Zhang et al. used 3D printing to create an electrically conductive material. The material is made up of a carbon nanotube conductive core and a silk fibroin dielectric sheath. This intelligent material has been proposed as a bioelectrical harvesting fabric that can be used in a variety of wearable electronics devices.



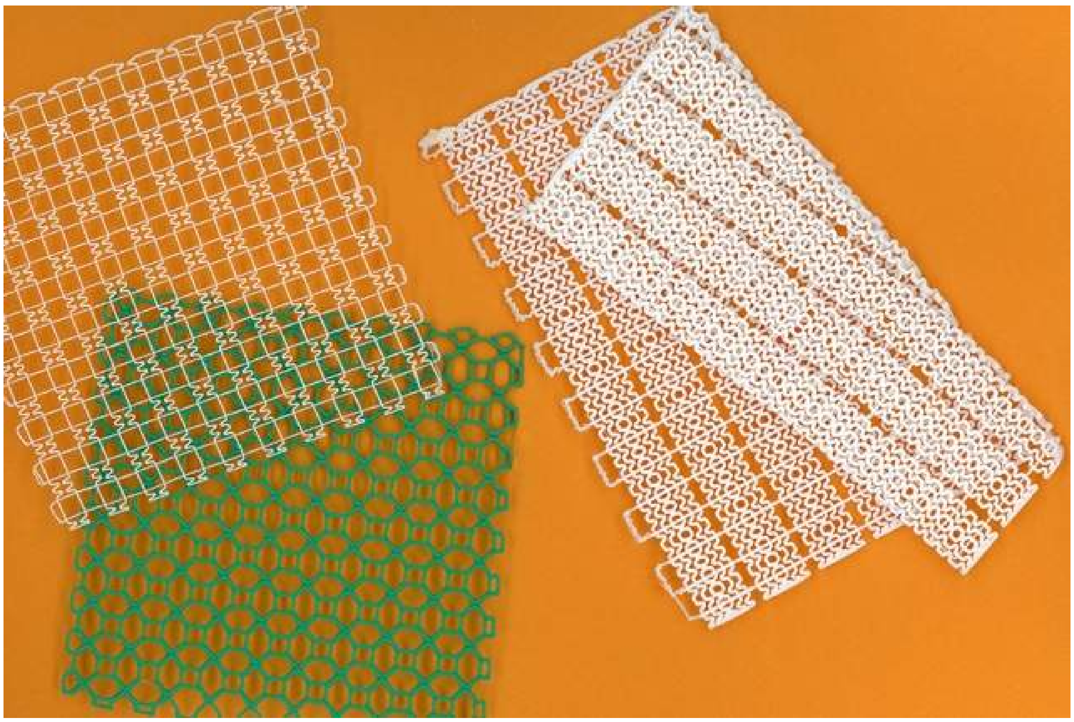
Materials with Enhanced Protective Performance

Wang et al. created an innovative 3D printed protective material using selective laser sintering in one study. This material is made up of interlocked granular particles that can change from soft, flexible, and wearable to hardened, protective.

When under pressure, the particles interlock and form a hard, chainmail-like structure that is 25 times stiffer than in its relaxed state. Analysis revealed that in this hardened state, the material can withstand loads of more than thirty times its own weight.

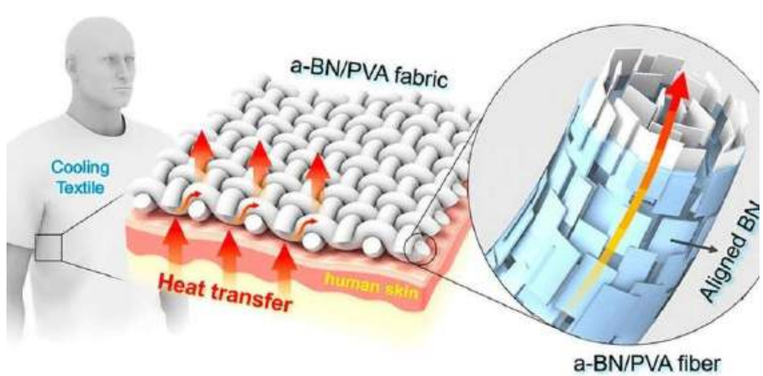
MIT’s Work on Soft Fabrics

TPU soft fabrics have been developed by MIT researchers. They were inspired by collagen, one of the main proteins in biological organisms that has an intertwined structure with enhanced flexibility and strength, when focusing on the structure of printed materials.
The researchers believe their invention could be used in the textile industry as well as in the medical field as cardiovascular stents, surgical mesh, and braces.



Heat-Wicking Materials: Producing 3D Printed Fabrics with Enhanced Cooling

University of Maryland researchers have created 3D printed materials with advanced heat-wicking capabilities. The material's novel structure, made of polyvinyl alcohol and boron nitride, maximises thermal conductivity by drawing heat in one direction and expelling it in the other. This effectively transforms the fabric into a low-cost, powerless air conditioner, with applications in sportswear and everyday clothing.



Haute couture: Iris Van Herpen

Iris Van Herpen's 3D printed artworks are undeniably iconic in the fashion industry. Her stunning gowns are well-known around the world, having been worn by actors and singers at gran galàs and other important events. Her works are one-of-a-kind, similar to sculptures.
She has always combined art and technology, inspired by the mind of Leonardo Da Vinci. Nature is her biggest counselor and all colors and shapes combinations come from animals and plants. Iris' fascination with nature and eco-systems drives her concern for sustainability and her desire to create environmentally friendly pieces.

https://youtu.be/mPjfFzrAuos

3D Printed Smart Clothing

It is a 3D printed interactive garment which has a camera embedded inside,it can seize the gaze, gender and even age based on where a people are looking and it moves and respond accordingly. It has a lots of inspiration from nature. It's a 3D printed using multi material 3D printing so it's soft and hard. In this various material properties is used.
Eight different materials is printed with object printers at pier nine. The garment has a feel of reptiles scales or even like birds feathers. In this garment there is a combination of nature with tech. As mentioned it has an eye tracking camera.
The camera is embedded inside the 3D printed object which can seize the eyes various information. It basically compute the yaw and pitch value where the people are looking at the motion of the garment, so basically where the user are looking at, its gonna move like a goosebump.

Adidas and the Futurecraft 4D

Adidas has introduced their Futurecraft 4D initiative, in which they manufacture shoes with a midsole built in collaboration with Carbon 3D, utilising a revolutionary technology known as Digital Light Synthesis (formerly known as CLIP). This technology may generate durable and resistant polymeric goods due to digital light synthesis, oxygen-permeable optics, and liquid resin.
Working on new designs to improve a prior product, for example, is possible using additive manufacturing in the footwear sector. That is exactly what occurred with this project: Adidas designed a stunning midsole with a lattice structure.
This experiment also demonstrates an intriguing element of additive manufacturing. These shoes are not only made using 3D technology, but they are also mass-produced with 3D printing.

ABL’s 3D Printed Watch

French company ABL "Atelier le Brézéguet" is based in Toulouse. This watch business utilised the 3D printing technology to create the black rings on the top and bottom of the timepiece. These components were created by 3D printing by using polyamide.

https://www.sculpteo.com/en/3d-learning-hub/applications-of-3d-printing/3d-printed-clothes/

Alexis Walsh Shows 3D Printed Spire Dress and Lysis Collection at New York Fashion Week

Alexis Walsh is a designer who created an impressive dress 3D printed using Selective Laser Sintering. The dress has 400 tiles assembled by hand. Here, 3D printing has been used to develop the design of the dress. It took at least six months to the designer to develop this impressive garment using 3D printing.

https://3dprint.com/119895/alexis-walsh-nyfw-2016/

Runway in Annual RAPID Fashion Show

RAPID + TCT brought the latest technologies and partnerships in the 3D printing world to the forefront as the event hit the Steel City for 2017.
The 3D printed fashion show has become an anticipated part of the event, high-tech garments and accessories hit the runway.

For 2017, designers featured included:
Laura Thapthimkuna
Julia Koerner
Sabina Saga
threeASFOUR

https://youtu.be/UHfndrAmSz8

https://3dprint.com/159138/3d-printed-vortex-dress/

New York Fashion Week

Runway at New York Fashion Week as textiles are using the technology for designs. Stratasys, threeAS-FOUR and Travis Fitch collaborated on the Chro-Morpho collection, which is inspired by microscopic colors and light filtering of butterfly wings.Using a Stratasys J750 PolyJet printer, designers were able to add polymers to textiles. For Stratasys, the aim is to develop the fashion market and enable more than 500,000 combinations of colors, textures, and transparencies.

 https://www.zdnet.com/article/3d-printing-plays-role-in-new-york-fashion-week-eyes-customization/

2022 MET GALA RED CARPET

Met Gala saw four gowns designed by fashion designer Iris van Herpen displayed on the Red Carpet, each featuring elements of 3D printing techniques.
The designs were worn by singer and actress Dove Cameron, singer-songwriter Teyana Taylor, model and activist Winnie Harlow, and Sweden's 'most stylish persona' Fredrik Robertsson.

Cameron's custom "Spiral Nebula" gown took inspiration from this year's theme of "the gilded age" and its ideals of pushing boundaries and embracing innovation.

Robertsson made his debut at the Gala wearing his bold "Quantum" jumpsuit. Making a sustainability statement, the jumpsuit is made from upcycled fabric that was digitally printed and then heat bonded to recycled mylar.

Harlow's "Transmotion" dress was complemented by her "Mind in Motion" crown.

Taylor's "Mythosphere" gown was brought to life by a striking face jewelry piece.

https://3dprintingindustry.com/news/iris-van-herpen-3d-printed-gowns-take-to-the-2022-met-gala-red-carpet-209142/

Fused Deposition Modeling (FDM)

Fused deposition modeling is an additive manufacturing technology that creates 3D components using a continuous thermoplastic or composite material thread in filament form. An extruder feeds the plastic filament through an extruding nozzle, where it is melted and then selectively deposited layer by layer onto the build platform in a predetermined automated path.

Characteristics and application of FDM

Temperature and build speed

Most FDM systems allow to adjust the nozzle and build platform temperature, build speed, layer height, and cooling fan speed. These are frequently set by the printing service provider and vary depending on the material.

Build volume

The largest part that the machine can build is the build volume. The build volume of a DIY 3D printer is typically 200 x 200 x 200 mm, whereas industrial machines can have build volumes as large as 1000 x 1000 x 1000 mm. Consider the build volume of the printer you intend to use during the design process. Larger models can be printed in smaller chunks and may perform better in terms of cooling.

Layer height

FDM layer heights range between 0.02 mm and 0.4 mm. A lower layer height produces smoother components and more accurately captures curved geometries, whereas a higher layer height produces parts that print faster and at a lower cost.

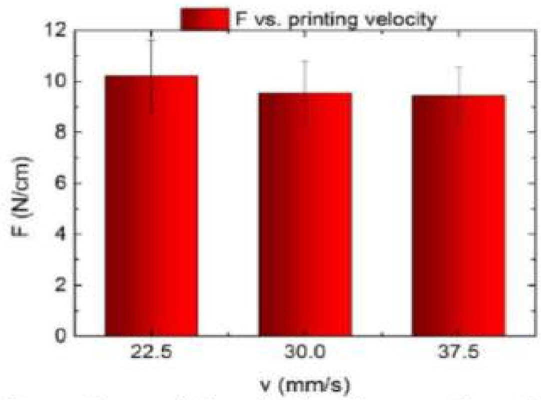
Layer Adhesion

Good adhesion between the deposited layers is critical for an FDM component. As the current is extruded, the molten thermoplastic is forced against the preceding layer. Because of the high temperature and pressure, the previous layer's surface is re-melted, allowing the new layer to connect with the previously printed portion. The binding strength between the multiple layers is always less than the base strength of the material.

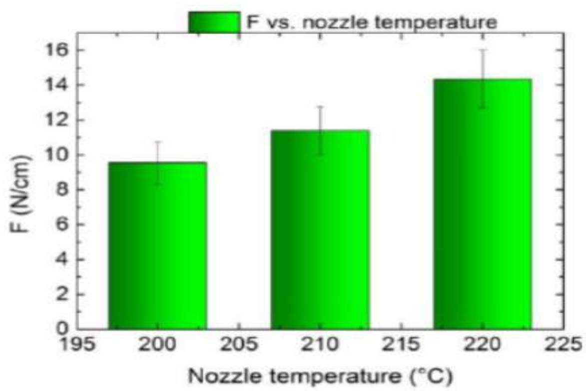
Support Structure

Geometries with overhangs will require a support structure in FDM. In the absence of air, the molten thermoplastic cannot be deposited. As a result, certain geometries require support structures.
The surface quality of surfaces printed on supports will be lower than the rest of the item. As a result, it is recommended that the part be designed in such a way that the need for assistance is reduced.
Support is typically printed on the same material as the print. Other support materials that can dissolve in liquid are available in industrial printers, but they are mostly used in high-end desktop or industrial FDM 3D printers. Printing on dissolvable supports greatly improves the surface quality of the item but raises the total cost of a print due to the requirement for a dual head FDM printer and the relatively high cost of the dissolvable material.

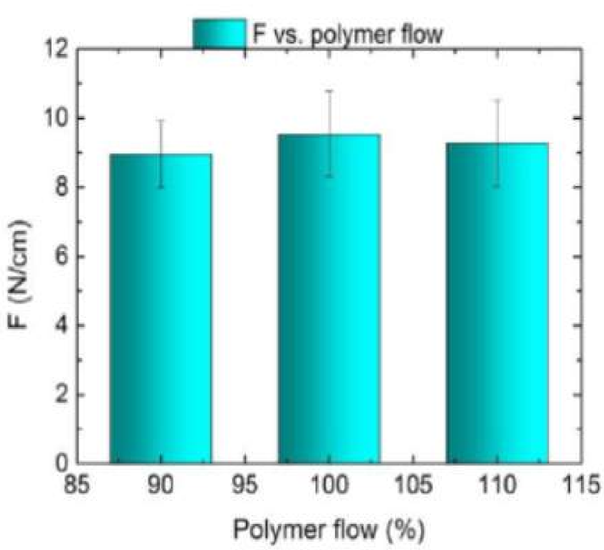
 https://www.researchgate.net/publication/321228371_Effect_of_3D_printing_on_textile_fabric



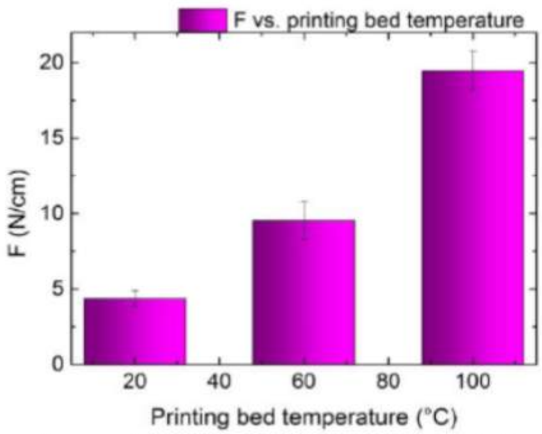
Dependence of the adhesion force on the printing velocity.



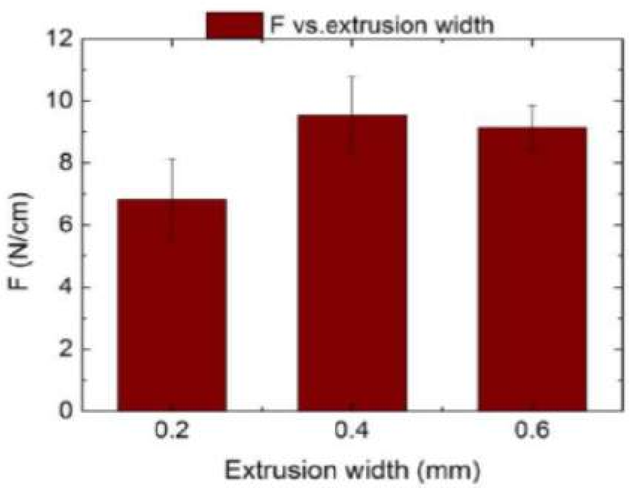
Dependence of the adhesion force on the nozzle temperature.



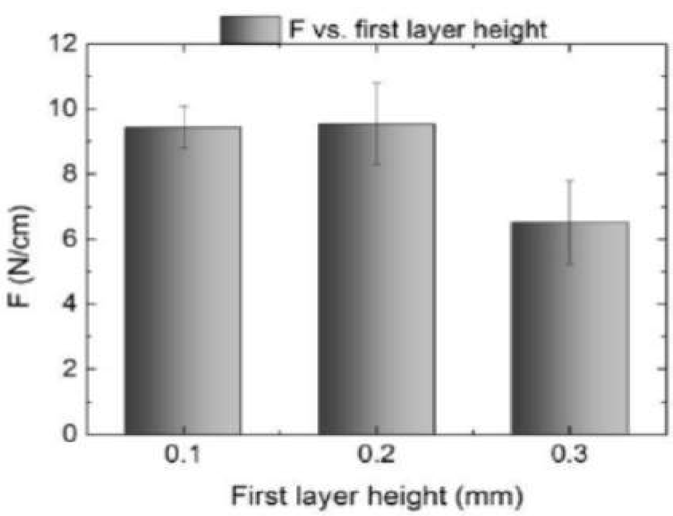
Dependence of the adhesion force on the polymer flow.



Dependence of the adhesion force on the printing bed temperature.



Dependence of the adhesion force on the extrusion width.



Dependence of the adhesion force on the first layer height.

Infill and Shell Thickness

To save time and material, FDM pieces are typically not produced solid. Instead, the exterior perimeter, known as the shell, is printed in multiple passes, and the interior, known as the infill, is printed with an internal, low-density structure.

Warping

One of the most common FDM flaws is warping. As the extruded material cools during solidification, its dimensions shrink. Because different parts of the print cool at different rates, their dimensions change at different rates. Internal tensions build up as a result of differential cooling, pulling the bottom layer higher and causing it to distort.

By closely monitoring and controlling the temperature of the chamber and the build platform, warping can be avoided. A good bond between the component and the build platform would also help to reduce warping.

Advantages of FDM

FDM is the most cost-effective way to create custom thermoplastic components and prototypes.

Because FDM printers are less expensive and more widely available, lead times are shorter and less expensive than for other additive manufacturing processes.

There is a wide range of thermoplastic materials available for prototyping, as well as some non-commercially viable options. FDM can replicate the majority of common injection moulding materials.

The technology is attractive, simple to use, and appropriate for the workplace.

Supported production-grade thermoplastics provide mechanical and environmental stability.

FDM technology allows for the creation of complex shapes and voids that would otherwise be impractical.

Disadvantages of FDM

FDM has the lowest dimensional accuracy and resolution when compared to other 3D printing methods, making it unsuitable for items with delicate features.

Because FDM items have visible layer lines, post-processing is required for a smooth finish.

FDM components are anisotropic by nature due to the layer adhesion technique.

Fused Deposition Modelling Materials

One of the most important aspects of FDM is the variety of materials available. From common thermoplastics like PLA and ABS to engineering materials like PA, TPU, and PETG. High-performance thermoplastics such as PEEK and PEI can be used for prototyping during the embodiment stages of a new product design.

ABS

ABS-M30 is a great material for conceptual modelling, functional prototyping, manufacturing tools, and end-of-life parts. ABS-M30 is ideal for production components, thermoforming tools, lightweight jigs and fixtures, and concept models because it is up to 70% stronger than conventional FDM ABS. This thermoplastic is extremely strong in terms of tensile, impact, and flexural strength. There is a choice of sparse or solid fill.
Advantages - Provides good strength and temperature resistance.
Cons: More prone to warping.

PC

PC (polycarbonate) is widely used in a variety of industries, including automotive, aerospace, and medicine. Precision, durability, and stability are provided by PC, resulting in strong parts that can withstand functional testing. Production tooling, jigs, and fixtures
Pros - Accuracy, rigidity, stability, RF transparency, high tensile and flexural strength
Cons - Limited availability, higher cost

PLA

PLA is a bioplastic that, along with ABS, is a standard material for this technology (Acrylonitrile Butadiene Styrene).
Pros - Excellent visual quality, simple to print
Cons: Limited impact strength

PC-ABS

PC-ABS combines the best qualities of both PC and ABS materials, such as high strength, heat resistance, and flexibility. PC-ABS composites are widely used in applications such as automotive, electronics, and telecommunications. Low volume production parts, form fit and functional prototypes
Advantages - High impact strength and heat resistance
Cons: Limited availability, higher cost

Nylon

Nylon is a popular commercial FDM material because it has a good combination of tensile strength and toughness. Rapid prototyping concept validation models, prototype parts for visual design validation, and production toolings such as jigs, fixtures, and manufacturing aids are common applications. It can also be used for low-volume production parts with fewer functional requirements.
Pros include high strength, excellent wear resistance, and chemical resistance.
Cons: Low humidity tolerance

PETG

Pros - Food safe, despite the fact that the grooves and grannies of notches between the layers are a critical point for bacterial growth, good strength, and easy to print
Cons - Limited availability, higher cost

TPU 92A FDM TPU Elastomer

It is a thermoplastic polyurethane substance that is used to create durable elastomer components. The material enables the development of high-functioning, long-lasting, and complex parts with the expected elastomeric material properties, such as enhanced tear resistance, fatigue resistance, and memory recovery.
Pros: Very flexible, tough, durable, and abrasion resistant.
Cons - Difficult to print precisely.

FDM Applications and Uses

Although the possibilities for product development and manufacturing are endless, the vast majority of applications fall into four broad categories:
Prototypes that work
Tools for production and manufacturing
Models of concepts
Parts of production quality

Conclusion

3D printing has provided some novel solutions for the textile industry and related fields. While the field is still in its infancy, the number of projects that are already presenting intriguing solutions to current commercial needs demonstrates the field's potential. There will undoubtedly be more innovation in the production of 3D printed fabrics as the field advances.

Reference

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