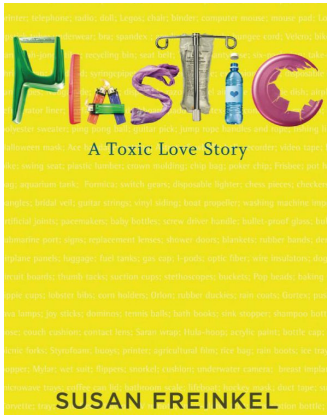
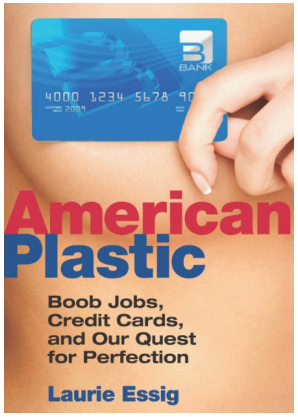
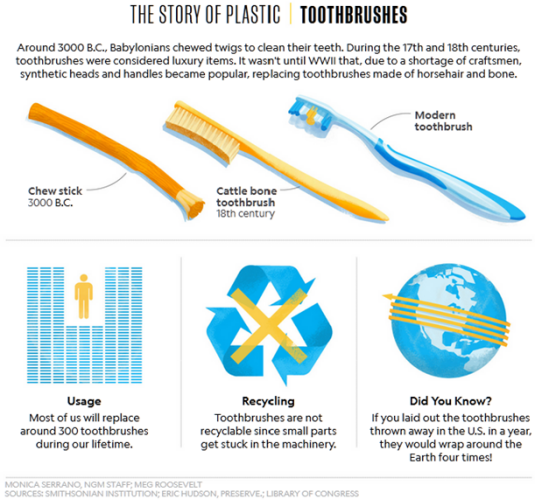
Polymers in Daily Life

Polymers are Indispensable in Our Daily Life



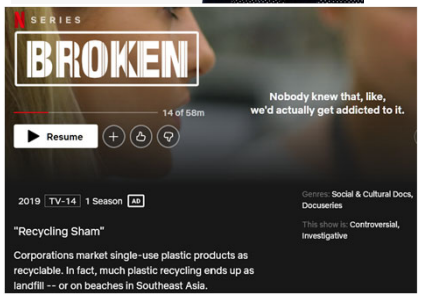




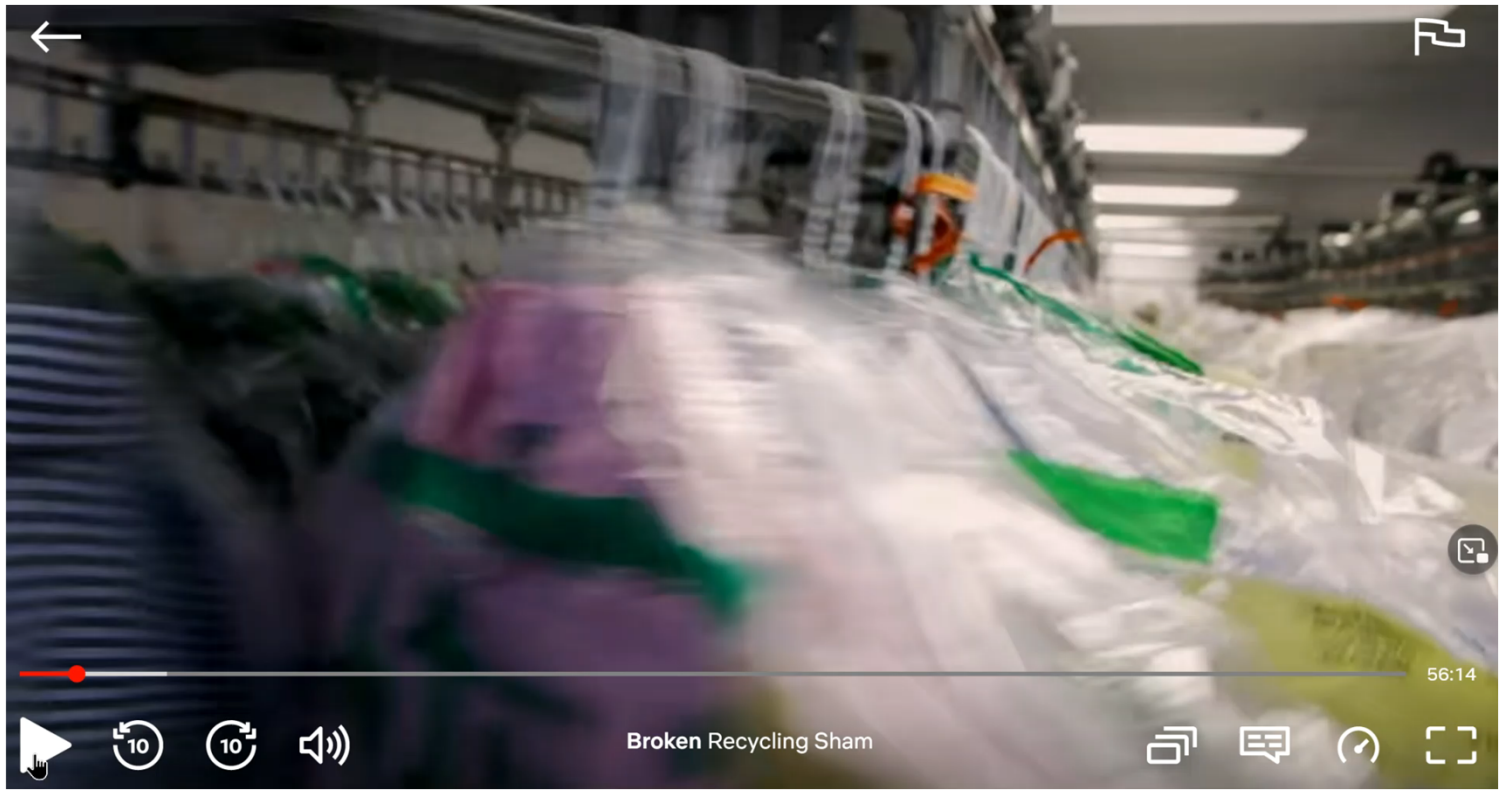
How your toothbrush became a part of the plastic crisis

A billion toothbrushes will be thrown away in the U.S. this year, most of them plastic. How did we get here, and can we change?

Polymers are Indispensable in Our Daily Life



Plastics: Inconvenient Truth



Netflix Series: Broken. Recycling Sham

Chemicals Used in Plastic Consumer Products

Adipogenic Activity of Chemicals Used in Plastic Consumer Products

Johannes Völker, Felicity Ashcroft, Åsa Vedøy, Lisa Zimmermann, and Martin Wagner*

Cite This: *Environ. Sci. Technol.* 2022, 56, 2487−2496 Read Online

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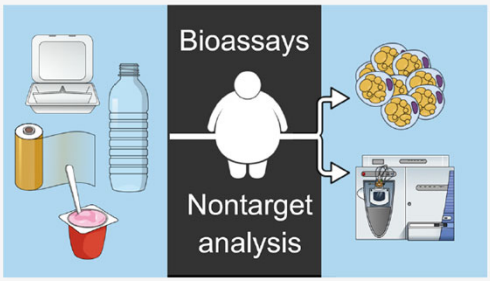
ABSTRACT: Bisphenols and phthalates, chemicals frequently used in plastic products, promote obesity in cell and animal models. However, these well-known metabolism-disrupting chemicals (MDCs) represent only a minute fraction of all compounds found in plastics. To gain a comprehensive understanding of plastics as a source of exposure to MDCs, we characterized the chemicals present in 34 everyday products using nontarget high-resolution mass spectrometry and analyzed their joint adipogenic activities by high-content imaging. We detected 55,300 chemical features and tentatively identified 629 unique compounds, including 11 known MDCs. Importantly, the chemicals extracted from one-third of the products caused murine 3T3-L1 preadipocytes to proliferate, and differentiate into adipocytes, which were larger and contained more triglycerides than those treated with the reference compound rosiglitazone. Because the majority of plastic extracts did not activate the peroxisome proliferator-activated receptor γ and the glucocorticoid receptor, the adipogenic effects are mediated via other mechanisms and, thus, likely to be caused by unknown MDCs. Our study demonstrates that daily-use plastics contain potent mixtures of MDCs and can, therefore, be a relevant yet underestimated environmental factor contributing to obesity.



KEYWORDS: *adipogenesis, endocrine-disrupting chemicals, metabolic disruptors, non-target chemical analysis, obesogens*

Volker 2022, Adipogenic activity of chemicals used in plastic consumer products

Table 1. Plastic Products Analyzed in this Study, Results of the Nontarget Chemical Analysis, and the Tentatively Identified MDCs

		LC-QTOF-MS/MS (number of features)				
sample	plastic product	in sample	with MS2	ID score ≥ 40	% of MS2	tentatively identified MDCs
HDPE 1	refillable drinking bottle[a]	779	203	38	18.7	TPP
HDPE 2	yogurt drinking bottle[a]	107	34	7	20.6	
HDPE 3	bin liner	614	153	30	19.6	TPP
HDPE 4	shower gel bottle	164	50	16	32.0	EHDP
LDPE 1	lemon juice bottle[a]	241	66	20	30.3	EHDP
LDPE 2	plastic wrap[a]	1833	543	98	18.0	TPP
LDPE 3	freezer bag[a]	1603	416	62	14.9	TPP
LDPE 4	hair conditioner bottle	1702	544	89	16.4	allethrin, TPP
PS 1	yogurt cup[a]	447	96	12	12.5	TPP
PS 2	fruit tray[a]	1122	293	44	15.0	DPP, TPP
PS 3	vegetable tray[a]	308	63	11	17.5	
PS 4	plastic cup[a]	119	30	7	23.3	
PP 1	refillable drinking bottle[a]	1365	396	87	22.0	TPP
PP 2	yogurt cup[a]	1870	549	93	16.9	TPP
PP 3	gummy candy packaging[a]	3159	910	117	12.9	TPP
PP 4	handkerchief packaging	1798	519	85	16.4	TPP
PP 5	shampoo bottle	268	101	29	28.7	
PET 1	soft drink bottle[a]	148	55	18	32.7	
PET 2	yogurt cup[a]	179	51	12	23.5	
PET 3	oven bag[a]	647	159	30	18.9	
PET 4	vegetable tray[a]	695	182	20	11.0	
PET 5	shampoo bottle	375	89	11	12.4	
PVC 1	plastic wrap[a]	3655	1374	118	8.6	
PVC 2	place mat	2426	819	145	17.7	DPP, TPP
PVC 3	pond liner	1270	450	91	20.2	DINP, TPP
PVC 4	floor covering	2361	868	145	16.7	BBP, BPDP, DBP, DEHP, DINP, DPP, EHDP, TBEP, TOCP, TPP
PUR 1	scouring pad	5619	1773	216	12.2	EHDP, TPP
PUR 2	kids bath sponge	4521	1182	151	12.8	
PUR 3	acoustic foam	6242	2117	224	10.6	EHDP, TPP
PUR 4	shower slippers	1035	300	78	26.0	EHDP, TPP
PLA 1	yogurt cup[a]	2421	772	52	6.7	TPP
PLA 2	vegetable tray[a]	1983	672	40	6.0	
PLA 3	coffee cup lid[a]	N/A	N/A	N/A	N/A	
PLA 4	coffee cup lid[a]	2575	857	73	8.5	

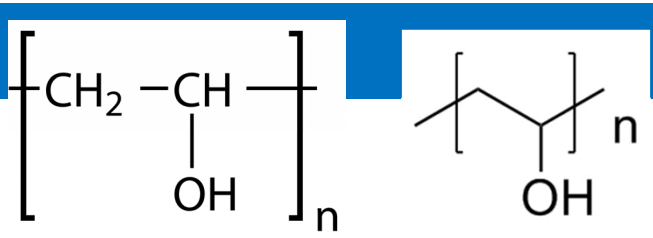
[a]FCM = food contact material, BBP = benzyl butyl phthalate, BPDP = tert-butylphenyl diphenyl phosphate, DBP = dibutyl phthalate, DEHP = bis(2-ethylhexyl) phthalate, DINP = di-iso-nonyl phthalate, DPP = diphenyl phosphate, EHDP = 2-ethylhexyl diphenyl phosphate, N/A = not analyzed, TBEP = tris(2 butoxyethyl) phosphate, TOCP = tri-o-cresyl phosphate, and TPP = triphenyl phosphate.

Planet-First Personal Care. Ethique Concentrates

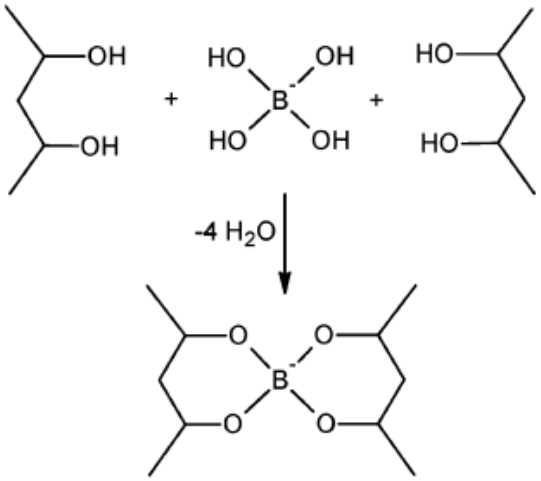
Some 95 percent of the shampoo, conditioner, and lotion that we use is water. Ethique gets rid of all of it, with a line of solid products ($6 to $9) that you use for hair, face, and body-care. Just add hot water, stir, and you're ready to go. Ethique's ingredients are environmentally-minded, as well: since they're smaller they require less packaging, and are sent in compostable material instead of plastic. (Marjorie Korn)

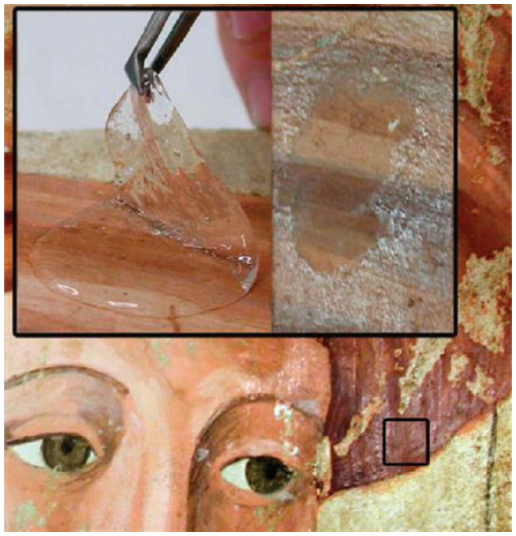
Polymers in Art

Art Conservation

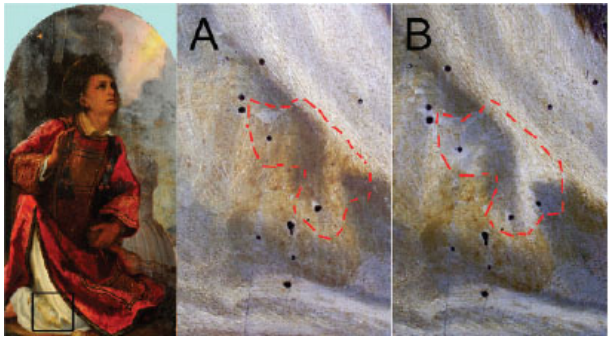


“Peelable” Gels. Hydrogels employing two component gellants, poly(vinyl alcohol) and borate as a crosslinker (PVA-B) have been investigated extensively. The ester cross-links are reversible, so a steady-state concentration of them is established. Initially formed gels “age”, allowing conformations of the polymer chains and locations of cross-links to change. Depending upon the length (i.e., average molecular weight) of the PVA chains, the concentrations of PVA and borate ion, temperature, and pH of the aqueous part, the gels can be very stiff or quite malleable.





We have investigated how these gels might be applied for cleaning surfaces of artwork, especially when the aqueous liquid is mixed with a cosolvent, 1-propanol (although propylene carbonate, 1-pentanol, cyclohexanone, and 2-butanol have been added as well). Because of their high elasticity, these gels can be peeled from a surface in one piece without introducing a strong lateral force or adding other chemicals.
Consistent with this effect, rheological measurements demonstrate that the gels become stronger, presumably as a result of more cross-links, with increasing 1-propanol concentration.



Carretti 2009, New frontiers in materials science for art conservation: Responsive gels and beyond.
Natali 2011, Structural and mechanical properties of “peelable” organoaqueous dispersions

Hydro Dipping (Hydrographic Printing)

Film: Designs are printed using a special kind of ink on a PVA (Polyvinyl Alcohol) film usually with a rotary printer and some small batches on wide format printers using special inks. This film is water soluble and is designed to absorb moisture which allows the film and ink to soften and become more pliable. Most films are designed to be hydrated on 90 °F water for 60 seconds. Some films such as our Metallic and 40 micron films still need 90 °F water but require longer to hydrate, about 90-120 seconds. When laying the film on the water, you need to be sure that you are laying the correct side of the film facing down.

Check for those air bubbles!! After you lay the film on the water, you will need to get close up and look for air bubbles trapped under the film. An air bubble will prevent that spot of the film from hydrating and therefor leave you with a spot of only your base coat after dipping. When you do find an air bubble, gently blow on it to make it move off to the side and out from underneath the film. Some air bubbles get stubborn and you may need to gently poke/press on it to get it to move.

Activator: Activator is a chemical that is used in the dipping process that makes it all possible. This chemical is applied to the film after the film has finished hydrating. When the activator is applied, it makes the film dissolve and liquefies the ink. When dipping with metallic films, you will need to apply a quick and light spray over the film as soon as you lay it on the water and again after it is done hydrating.

Activator: In chemistry, many different chemicals can produce the same effects. Therefore there isn't such a thing as the best formula for the activator. As said, this substance is a kind of evaporating paint thinner. And every paint thinner mixture which includes a solvent like xylene can become water transfer activator.

- Xylene – 42%
- Isobutanol – 5%
- Butyl – 17%
- Methyl acetate – 28%
- MEK – 8%

- Xylene – 52.94%
- Methyl isobutyl ketone (MIBK) – 25.88%
- Methyl ethyl ketone (MEK) – 11.18%
- Isophorone – 5%
- Cyclohexanone – 5%

https://www.hydrocreations.com/blogs/news/what-is-hydro-dipping
https://shootingmystery.com/easy-make-hydrographic-activator-home/

Artistic Polymers

Artist Spray-Paints Animals On Plastic Wrap In The Forest
A few years ago Evgeny Ches discovered a form of graffiti called cellograffiti where artist paint on industrial strength plastic film fixed between two columns or trees. Intrigued by the medium, Ches started using it in his own work.
Ches then got inspired to take the street art aspect of cellograffti and move it to a more natural environment. Here he could place creatures from the wild in the actual wild.



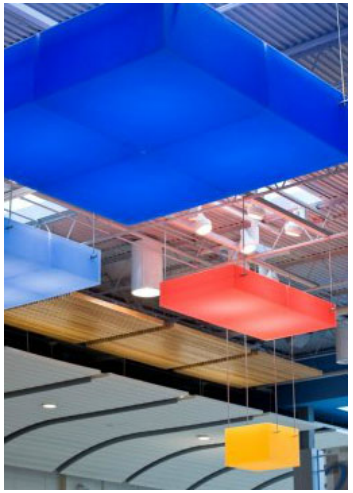



https://www.buzzfeed.com/javiermoreno/this-artist-spray-paints-animals-on-plastic-wrap-in-the?utm_term=.qaKmyKQnBB#.lqJoBrOYqq

http://www.blueridgefilms.com/index?_vsrefdom=ppcgoogle&ex=ek9ye0-eep549-1dg8cka&gclid=EAIaIQobChMIvN-fs4uw2AIVjLbACh0PVACEEAAYASAAEgITbPD_BwE

Plastic Films
Primary materials include polyethylene (PE), low density polyethylene (LDPE), high density polyethylene (HDPE), high molecular weight high density (HMWHDPE) film, polypropylene (PP), and polyvinyl chloride (PVC) with plasticizer.

Light Blocks & Colorful Polymers



http://www.lightblocks.com/

BusinessWeek SmallBiz **FRONTLINE**

WHO'S HOT

Plastic Fantastic

THE MATERIAL GIRL AT LIGHTBLOCKS **BY KEVIN FERGUSON**

THE COLOR OF MONEY on Canal Street in Nashua, N.H., is tangerine one day and magenta the next. It's there, in a 20,000-square-foot converted luggage factory, that artist Mary Boone Wellington has built a highly profitable business from one of her creations: sturdy sheets of tinted plastic used in retail displays, chi-chi restaurant ceilings, and avant-garde corporate boardrooms.

Wellington makes the translucent material, called LightBlocks, using a patented technique that treats and colors sheets of acrylic or polycarbonate to form a pliable plastic that is nearly impossible to scratch and, when backlit, seems to glow. "When a designer holds a piece in their hand, they often get a dreamy look as though it's catalyzing some inspiration," says Wellington. "It just seems to spark off a lot of new concepts."

Sales are pretty bright, too. Six-year-old M.B. Wellington Studio had revenues of $3 million in 2004, up from about $1.5 million the previous year. Wellington's portfolio includes IBM's eBusiness offices, Discovery Channel stores, and Los Angeles' Beverly Center shopping mall. She has just signed contracts with Hilton, Sony, AOL, and BMW.

The 55-year-old Wellington, who once studied under Siddha yoga teacher Swami Muktananda, peppers talk about polymers with her spiritual philosophies. But she shatters the stereotype that artists don't make good businesspeople. In the 1990s she sold about 1,100 of her oil paintings in four years. "I had 25 dealers selling my art," recalls Wellington. "The perception is that artists are flaky. But I would get things done, so I would get the commissions."

LUMINOUS: Wellington is poised between art and business

M.B. WELLINGTON STUDIO

WHO: Mary Boone Wellington
WHERE: Nashua, N.H.
REVENUES: $3 million
EMPLOYEES: 26
THE BUSINESS: Creating and selling LightBlocks, colored plastic sheets used in buildings and sculpture.
THE BUZZ: The former painter recently added AOL, BMW, Hilton, and Sony to her already fat portfolio of companies and architectural firms.

It was a commission that led her to LightBlocks. In 1998 the city of Flagstaff, Ariz., hired Wellington to build a 75-by-45-foot solar calendar along Route 66, consisting of 12 colored towers that would glow at dusk. She couldn't find the right material, as existing plastics came in limited colors and easily faded and scratched. Wellington had no formal science training, but she began researching polymers, touring plastics factories, and thumbing through textbooks. After plenty of trial and error, and $14,000 of her own money on top of the $50,000 commission, Wellington hit upon a process to give plastic the quality she wanted. She patented it in May, 2003.

Right away, she knew LightBlocks were different. "I'd been selling stuff for a long time, but no one raved about things they way they did about LightBlocks," she says. Wellington sent product samples to 100 top architectural firms. The result was a 33% order rate. "That was phenomenal. I had heard that a 2% response rate was good," she says.

One of those orders came from fellow Philadelphia University of the Arts alum Ron Pompei, whose New York firm Pompei AD used LightBlocks in the design of Discovery Channel's flagship store in Washington, D.C. "One of the most subtle things about LightBlocks is the way light goes through it," says Pompei. "She has applied an artistic process to something you'd use in an automated or industrial setting. It's not arts and crafts, and it's not industrial. It holds a great middle ground."

In 2000, IBM wanted LightBlocks for offices in three cities—in two months. Wellington hustled to expand her six-person staff by hiring 10 temps and moved from her tiny studio to her current space. Since that success, dozens of corporate offices—and the future of Wellington's studio—have been looking a lot brighter.

MARK WILSON

a mood ring than an industrial technology: It's a gelatinous material that can be formed to any shape—from a flat sheet to an autumn leaf—and responds to changes in temperature, pressure, moisture, or acidity by changing color.

Developed by materials science professor Edwin Thomas and teammates at Massachusetts Institute of Technology, it's made up of repeating, ultrathin layers of polystyrene and a patented polymer whose molecules change shape, from short and coiled to flat and long, as conditions shift.

When the molecules extend and contract, they reflect different wavelengths of light, determining the hue. One use could be to identify food that's gone bad: "You want your potato chips to be dry and crisp," says Thomas. "So if a bit of gel in the packaging goes blue, you know moisture has crept in."

The gel changes hue with shifts in temperature, moisture, acidity, or pressure

http://opticalceu.blogspot.com/2015/02/new-polymers-provide-rainbow-of-colors.html

Polymers in Clothes

Coperni Spray-On Dress

Bella Hadid Closed Coperni With a Spray-On Dress
Wearing nothing but nude underwear, the model got her finale look painted on in front of the audience. (Fashionista, Sep 30, 2022).

Alexander McQueen put on more than his fair share of legendary runway shows before his tragic passing in 2010. But none were so instantly iconic as the late designer's Spring 1999 womenswear collection, which saw supermodel Shalom Harlow walk out in a crisp, all-white dress that a pair of mechanical robots spray-painted with black and yellow graffiti.

In an unexpected bit of fashion-week theater, Coperni — the buzzy French label co-founded by Sébastien Meyer and Arnaud Vaillant — paid homage to the historic moment in its own way. On Friday evening in Paris, Bella Hadid closed the French label's Spring 2023 presentation, with a McQueen-ian twist: Wearing nothing but nude underwear, the model got her one-shouldered finale dress sprayed on in front of the audience.

How, exactly?
According to *Vogue* Business, the spray-on technique came courtesy of material-science company Fabrican; its a proprietary liquid contains cotton or synthetic fibers suspended in a polymer solution that evaporates when it makes contact with the body. This finale was a long-time coming, as it turns out, with Meyer and Vaillant reportedly working with Fabrican Founder Manel Torres to perfect the spray-on effect over the past six months. It's an especially fitting technological demonstration for Coperni, which has built a business on '60s-era retrofuturism since its 2013 launch.

https://fashionista.com/2022/09/coperni-spring-2023-bella-hadid-spray-on-dress
https://www.elle.com.au/fashion/how-coperni-spray-on-dress-made-27760

Bella Hadid in Coperni's Spring 2023 runway show.

The innovative material has been in development since the early 2000s. Short fibers are bound together with natural and synthetic polymers and then mixed with liquid solvents that immediately evaporate once the aerosol hits skin or other surfaces, according to a press release from the British company behind the technology. The fabric's texture can also be manipulated according to the type of fibers and binding agent used.
https://www.cnn.com/style/article/bella-hadid-coperni-spray-on-dress/index.html

Spray-On Fabric

What exactly is in Fabrican? According to the patents granted to the company, the liquid fabric is made up of a suspension of liquid polymers (large molecules bonded together), additives, binders like natural latex, cross-linked natural and synthetic fibers, and a fast-evaporating solvent like acetone. The fibers can be polyester, polypropylene, cotton, linen, or wool.
https://www.popsci.com/technology/fabrican-spray-on-dress/

Face masks and protective garments
Fabrican's sprayable fabric technology in combination with robotic spray technology offers a revolutionary method of rapidly manufacturing face masks and protective garments. The technology also facilitates low-capital, local production in many parts of the world and the manufacture of variable sizes and shapes without the need for expensive or complex retooling.

Skin screen-material protector, Touch sensitive-nano transfer, Sustainable and sterile from a sealed point of application
Given developments in the pharma/biotech industry, and the flexible adhesive properties of Fabrican's technology, we are looking at several new and exciting applications, including: New types of patches, Wound healing products, Dressings, bandages and casts, Slow release systems, Many other innovative uses.

Casts and Bandages
Fabrics can be produced in varying degrees of durability and strength to accommodate uses such as wound dressings, bandages and casts. Other applications will be discovered by specialist user groups, as Fabrican is adaptable and flexible.

Transdermal Drug Delivery
Transdermal drug delivery is a system of administering drugs through patches placed on the skin. The most widely known form is the nicotine patch. Transdermal delivery has many advantages over other drug delivery systems, such as: Controlled release of the drug into the patient, Enables a steady blood-level profile, Reduces systemic side effects (less stress on internal organs such as the liver and the stomach), Non-invasive drug delivery system

The use of Spray on Fabrics for patches combines traditional advantages with the aesthetic sensibilities of Fabrican. Patients are able to choose a spray that matches their skin tone to better hide the patch, making them less self-conscious. Alternatively, they could choose bright colours and apply a design of their own choosing, coordinating the patch with their own personal fashion and style. When samples were made the concentration in the patches was comparable to standard nicotine patches (delivery of 10 micro grams). There was no detrimental effect to the performance of the spray or the quality of the final fabric. Fabrican may also be used to create waterproof, yet flexible and soft coverings. In this respect it is an ideal resource for hospitals, hospices, hotels, or anywhere that has lots of beds. And can benefit from are the strength and hard-wearing attributes of Fabrican. https://www.fabricanltd.com/applications/healthcare/

Speedo LZR Racer

The specially engineered, highly flexible fabric called LZR PULSE™ is ultrasonically welded so as to appear seamless.

At the Beijing Olympics, 98% of medal winner were wearing the LZR racer.

Construction

Bonded Seams

The Speedo LZR Racer is the world's first fully bonded bodysuit. It's full-length bonded seams are ultrasonically welded together to eliminate stitching, creating the most low profile silhouette and reducing skin friction drag.

Low Profile Zipper

The ultra low profile zip is also bonded into the suit and hidden inside to maintain a smooth surface shape.

Fabric

The Speedo LZR Racer is made from Speedo's own LZR Pulse material- the world's lightest woven swim fabric. It is highly compressive, water repellent, chlorine resistant and fast drying.

LZR Panels

The LZR Racer features LZR panels, an ultra-thin polyurethane membrane precision cut by laser into panels, which are embedded into the base LZR Pulse fabric.

Hydro Form Compression

The LZR Pulse fabric was strategically placed at important parts of the body to create a Hydro Form Compression system that provides optimum streamlined shape and drag reduction for the swimmer. This system also provides a core stabilizer built to support and hold the athlete in.

A Short-Lived Victory

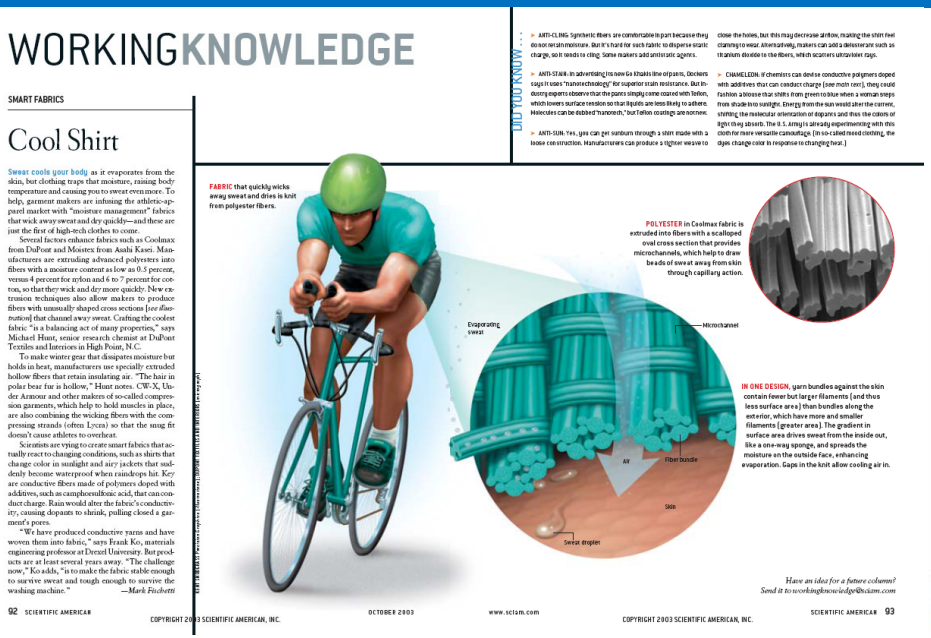
There has been little to no conversation on the impact of technology in swimming—even though the LZR Racer threw the sport for a loop after its smash performance in the Olympics when it was first released.

The introduction of the LZR Racer in the 2008 Beijing Olympics had an incredible effect on the race results. Winners of 94 percent of the races and 92 percent of world record-setting races had competed in the swimsuit. The suit was so effective at reducing drag and improving performance that FINA, the international governing body of water sports, was forced to ban the use of the LZR Racer in future competitions. In fact, the suit was regarded as a form of "technological doping," with the argument being that the LZR Racer only served to diminish natural ability, therefore threatening the integrity of the sport.

Italian swimsuit manufacturer Jaked was also one of the few dozen companies that rode the high-tech swimsuit hype following Speedo's success. The ban was enacted beginning in 2010 and required swimmers to use swimsuits made out of permeable materials instead. The new mandate also established certain limits on how much a swimmer's body could be covered, further preventing the use of any kind of high-tech full-body swimsuits. While Phelps did manage to score several records with the LZR Racer, he was still supportive of FINA's decision.

https://www.engineering.com/story/the-technology-behind-speedos-high-tech-swimsuits-that-challenged-the-olympics

Polyester Fiber Coolmax



WORKINGKNOWLEDGE

SMART FABRICS

Cool Shirt

Sweat cools your body as it evaporates from the skin, but clothing traps that moisture, raising body temperature and causing you to sweat even more. To help, garment makers are infusing the athletic-apparel market with "moisture management" fabrics that wick away sweat and dry quickly—and these are just the first of high-tech clothes to come.

Several factors enhance fabrics such as Coolmax from DuPont and Moistex from Asahi Kasei. Manufacturers are extruding advanced polyesters into fibers with a moisture content as low as 0.5 percent, versus 4 percent for nylon and 6 to 7 percent for cotton, so that they wick and dry more quickly. New extrusion techniques also allow makers to produce fibers with unusually shaped cross sections [*see illustration*] that channel away sweat. Crafting the coolest fabric "is a balancing act of many properties," says Michael Hunt, senior research chemist at DuPont Textiles and Interiors in High Point, N.C.

To make winter gear that dissipates moisture but holds in heat, manufacturers use specially extruded hollow fibers that retain insulating air. "The hair in polar bear fur is hollow," Hunt notes. CW-X, Under Armour and other makers of so-called compression garments, which help to hold muscles in place, are also combining the wicking fibers with the compressing strands (often Lycra) so that the snug fit doesn't cause athletes to overheat.

Scientists are vying to create smart fabrics that actually react to changing conditions, such as shirts that change color in sunlight and airy jackets that suddenly become waterproof when raindrops hit. Key are conductive fibers made of polymers doped with additives, such as camphorsulfonic acid, that can conduct charge. Rain would alter the fabric's conductivity, causing dopants to shrink, pulling closed a garment's pores.

"We have produced conductive yarns and have woven them into fabric," says Frank Ko, materials engineering professor at Drexel University. But products are at least several years away. "The challenge now," Ko adds, "is to make the fabric stable enough to survive sweat and tough enough to survive the washing machine." —*Mark Fischetti*

FABRIC that quickly wicks away sweat and dries is knit from polyester fibers.

POLYESTER in Coolmax fabric is extruded into fibers with a scalloped oval cross section that provides microchannels, which help to draw beads of sweat away from skin through capillary action.

Microchannel

Evaporating sweat

IN ONE DESIGN, yarn bundles against the skin contain fewer but larger filaments (and thus less surface area) than bundles along the exterior, which have more and smaller filaments (greater area). The gradient in surface area drives sweat from the inside out, like a one-way sponge, and spreads the moisture on the outside face, enhancing evaporation. Gaps in the knit allow cooling air in.

Air

Fiber bundle

Skin

Sweat droplet

Have an idea for a future column? Send it to workingknowledge@sciam.com

DID YOU KNOW . . .

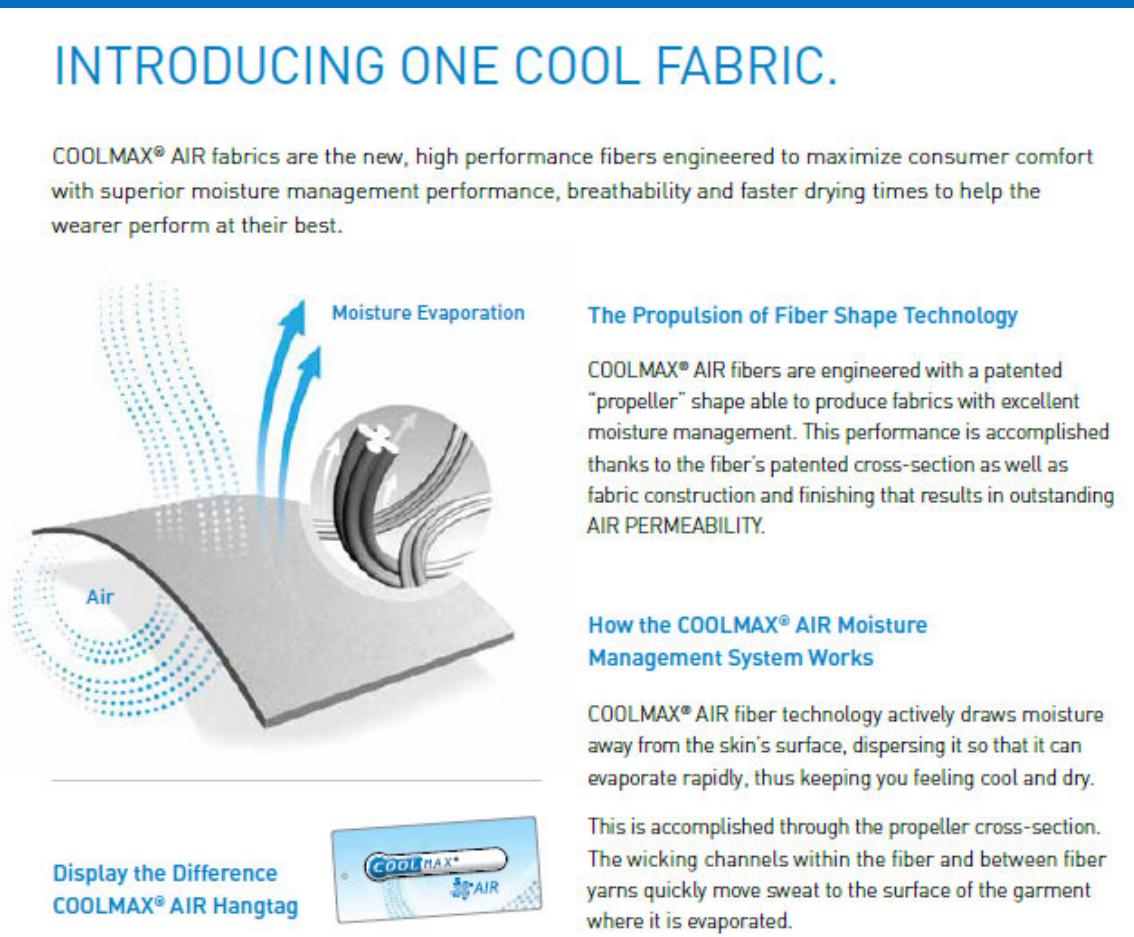
► ANTI-CLING. Synthetic fibers are comfortable in part because they do not retain moisture. But it's hard for such fabric to disperse static charge, so it tends to cling. Some makers add antistatic agents.

► ANTI-STAIN. In advertising its new Go Khakis line of pants, Dockers says it uses "nanotechnology" for superior stain resistance. But industry experts observe that the pants simply come coated with Teflon, which lowers surface tension so that liquids are less likely to adhere. Molecules can be dubbed "nanotech," but Teflon coatings are not new.

► ANTI-SUN. Yes, you can get sunburn through a shirt made with a loose construction. Manufacturers can produce a tighter weave to close the holes, but this may decrease airflow, making the shirt feel clamming to wear. Alternatively, makers can add a sunscreen such as titanium dioxide to the fibers, which scatters ultraviolet rays.

► CHAMELEON. If chemists can devise conductive polymers doped with additives that can conduct charge [*see main text*], they could fashion a blouse that shifts from green to blue when a woman steps from shade into sunlight. Energy from the sun would alter the current, shifting the molecular orientation of dopants and thus the colors of light they absorb. The U.S. Army is already experimenting with this cloth for more versatile camouflage. (In so-called mood clothing, the dyes change color in response to changing heat.)

COOLMAX® AIR fibers are engineered with a patented “propeller” shape able to produce fabrics with excellent moisture management. This performance is accomplished thanks to the fiber’s patented cross-section as well as fabric construction and finishing that results in outstanding AIR PERMEABILITY. COOLMAX® AIR fiber technology actively draws moisture away from the skin’s surface, dispersing it so that it can evaporate rapidly, thus keeping you feeling cool and dry. This is accomplished through the propeller cross-section. The wicking channels within the fiber and between fiber yarns quickly move sweat to the surface of the garment where it is evaporated. In addition, the high air permeability results in the exchange of the microclimate, adding the potential for additional cooling. The COOLMAX® AIR hangtag provides a powerful visual identity and the unique consumer selling propositions are captured right on the label. *U.S. Patent: 6,855,420 B2.



INTRODUCING ONE COOL FABRIC.

COOLMAX® AIR fabrics are the new, high performance fibers engineered to maximize consumer comfort with superior moisture management performance, breathability and faster drying times to help the wearer perform at their best.

Moisture Evaporation

Air

The Propulsion of Fiber Shape Technology

COOLMAX® AIR fibers are engineered with a patented “propeller” shape able to produce fabrics with excellent moisture management. This performance is accomplished thanks to the fiber’s patented cross-section as well as fabric construction and finishing that results in outstanding AIR PERMEABILITY.

How the COOLMAX® AIR Moisture Management System Works

COOLMAX® AIR fiber technology actively draws moisture away from the skin’s surface, dispersing it so that it can evaporate rapidly, thus keeping you feeling cool and dry.

This is accomplished through the propeller cross-section. The wicking channels within the fiber and between fiber yarns quickly move sweat to the surface of the garment where it is evaporated.

In addition, the high air permeability results in the exchange of the microclimate, adding the potential for additional cooling.

Display the Difference COOLMAX® AIR Hangtag

The COOLMAX® AIR hangtag provides a powerful visual identity and the unique consumer selling propositions are captured right on the label.

Radiative Human Body Cooling By Nanoporous Polyethylene Textile

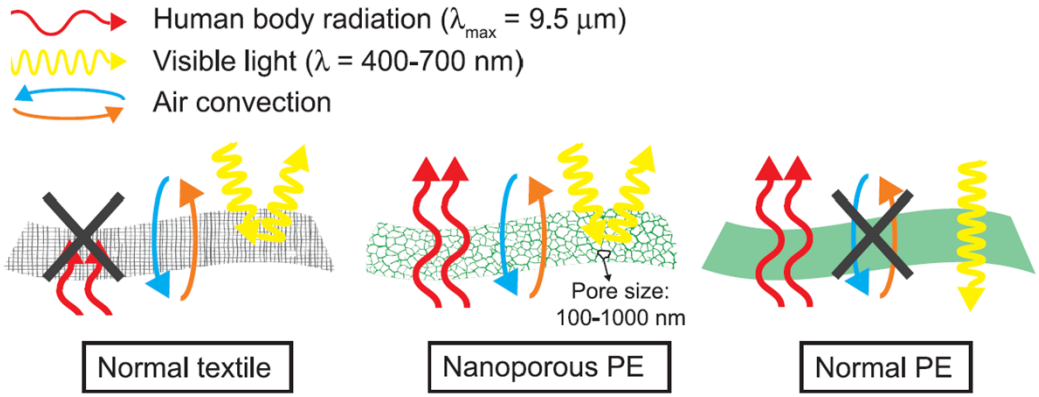
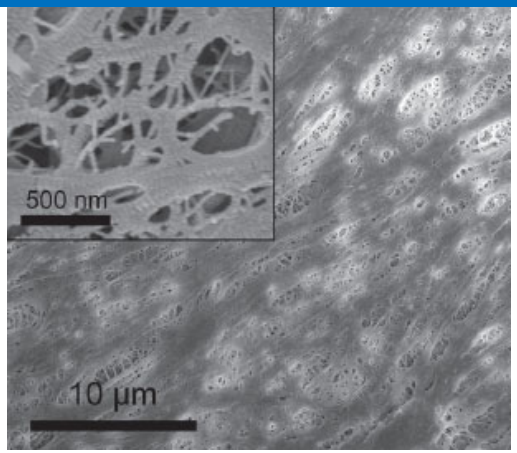


Fig. 1. Optical property and morphology of nanoPE. Schematics of comparison between nanoPE, normal PE, and cotton. Only nanoPE satisfies IR transparency, visible light opacity, and air convection simultaneously.



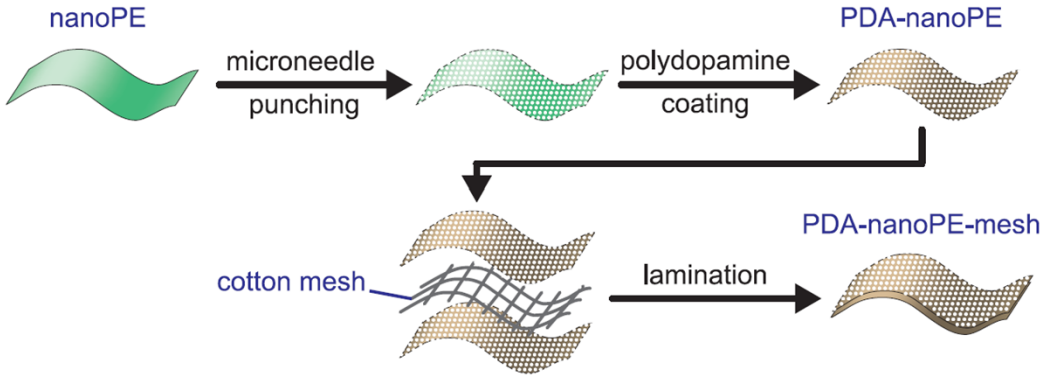


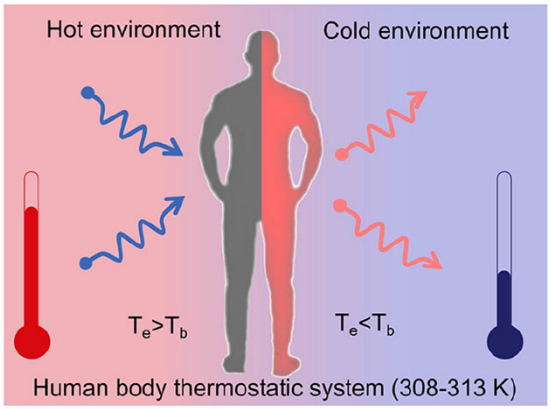
Fig. 3. The treatment of nanoPE for various wearability testing. (A) Schematic of the fabrication process of PDA-nanoPE-mesh. In all the textile tests, PDAnanoPE-mesh shows performance comparable with that of cotton.

Thermal management through personal heating and cooling is a strategy by which to expand indoor temperature setpoint range for large energy saving. We show that nanoporous polyethylene (nanoPE) is transparent to mid-infrared human body radiation but opaque to visible light because of the pore size distribution (50 to 1000 nanometers). We processed the material to develop a textile that promotes effective radiative cooling while still having sufficient air permeability, water-wicking rate, and mechanical strength for wearability. We developed a device to simulate skin temperature that shows temperatures 2.7 °C and 2.0 °C lower when covered with nanoPE cloth and with processed nanoPE cloth, respectively, than when covered with cotton.Our processed nanoPE is an effective and scalable textile for personal thermal management.

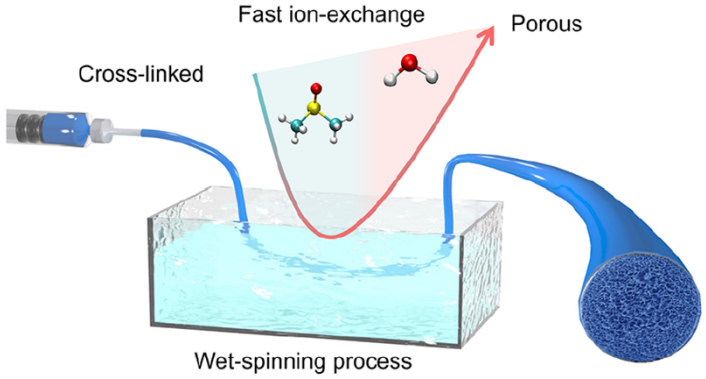
Hsu 2016, Radiative human body cooling by nanoporous polyethylene textile.

Stretchable Thermoelectric Fibers

Thermoelectric fibers for low-grade body heat energy harvesting.



Schematic images of the temperature difference between the human body and the ambient environment.



Schematic diagram of the preparation process for the 2D $Ti_3C_2T_x$based 3D porous fiber using a wet-spinning method.

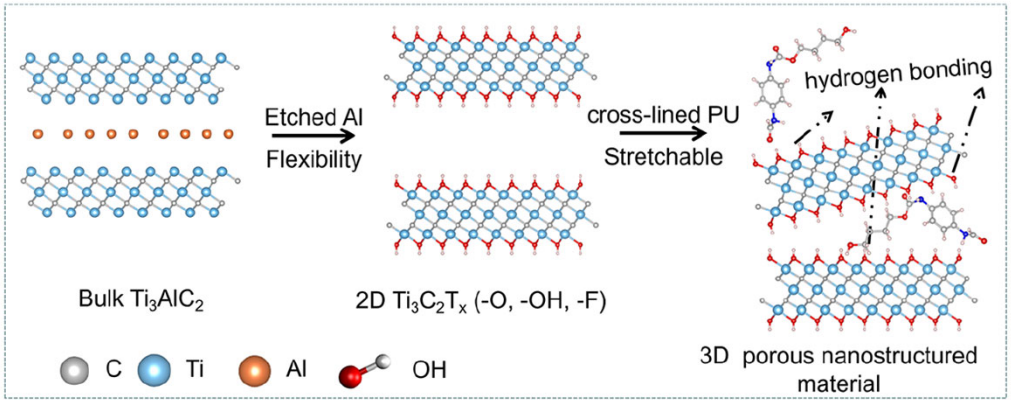
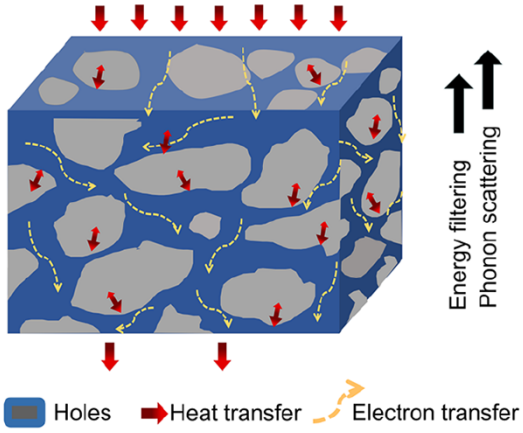
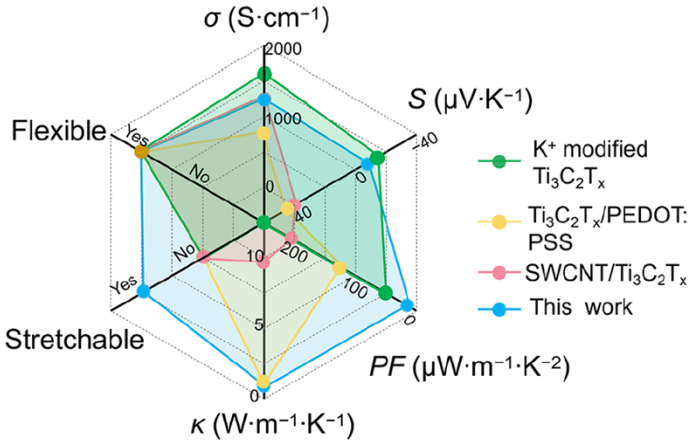


Illustration of 2D layered materials for 3D nanostructures and potential improvement in wearable thermoelectric generators.



Structure diagram of heat and electron transfer throughout the microstructure of a porous MP fiber.



Radar chart comparing the performance of the 2D $Ti_3C_2T_x$ MXene-based thermoelectric fiber with previous 2D $Ti_3C_2T_x$ MXene-based thermoelectric materials.

Li 2023, Stretchable thermoelectric fibers with 3-D interconnected porous network for low-grade body heat energy harvesting

Polymer Complex Fiber

Polymer complex fibers (PCFs) are a novel kind of fiber material processed from polymer complexes that are assembled through noncovalent interactions. These can realize the synergy of functional components and miscibility on the molecular level. The dynamic character of noncovalent interactions endows PCFs with remarkable properties, such as reversibility, stimuli responsiveness, self-healing, and recyclability, enabling them to be applied in multidisciplinary fields.

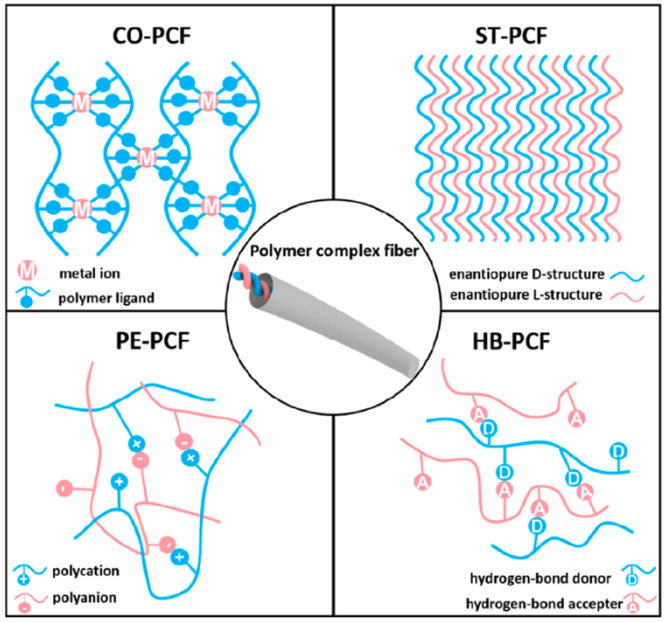


Figure 1. Schematic illustration of four kinds of PCFs based on molecular interactions, including coordination complex fiber (CO-PCF), stereocomplex fiber (ST-PCF), polyelectrolyte complex fiber (PE-PCF), and hydrogen-bonded complex fiber (HB-PCF).

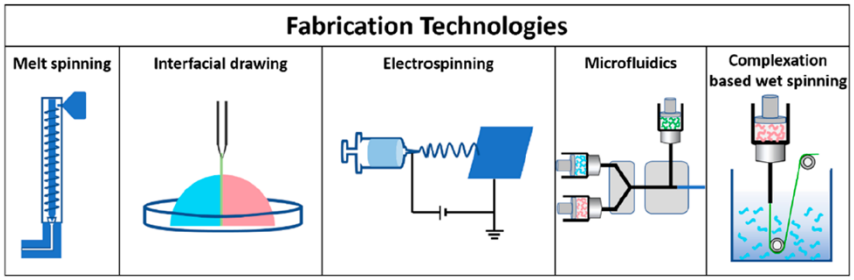


Figure 2. Schematic summarization of five fabrication technologies, melt spinning, interfacial drawing, electrospinning, microfluidics, and complexation based wet spinning.

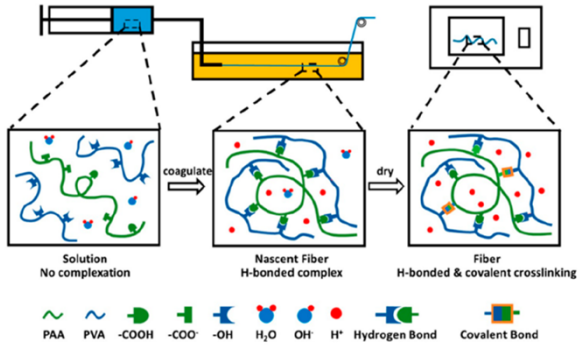


Figure 8. pH-induced fiber length change.

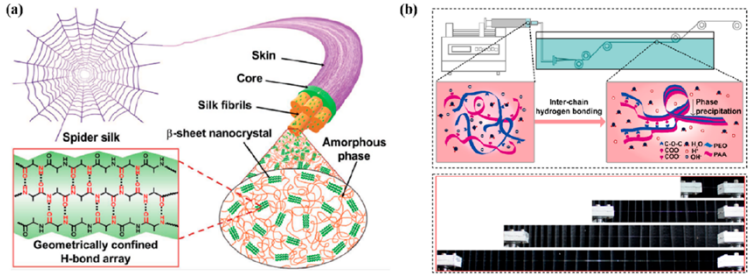


Figure 10. Schematic illustration of the hydrogen-bonding induced elastic behavior: (a) the spider silk; (b) PAA/PEO HB-PCF.

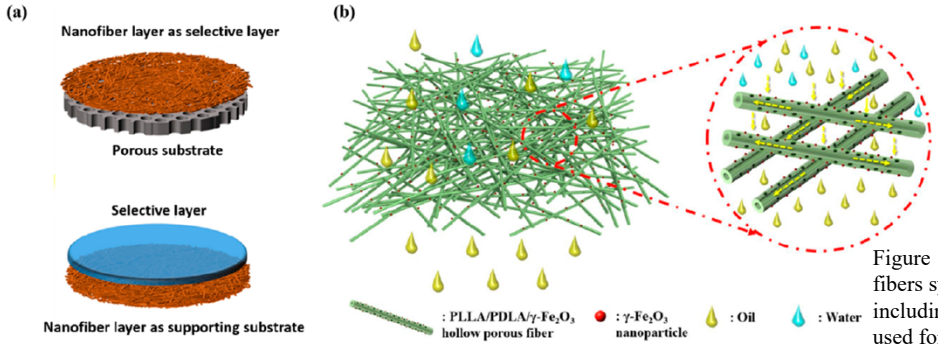


Figure 13. Fabrication of polymer complex fibers systems used in water treatment including (a) electrospun nanofibrous mats used for multiple-ion removal and (b) PLA nanofibrous mats used for oil/water separation.

Huang 2023, Polymer complex fiber- property, functionality, and applications

Environment-Friendly (Non-Planet-Polluting) Sequins

Nondegradable plastic sequins

Sequins made from biodegradable materials + 20% PET (Sustainable Sequin Company)

Chloe Street
December 15, 2021
Evening Standard

https://www.standard.co.uk/insider/boden-bans-sequins-sparkle-b971827.html

Boden one of first major fashion brands to ban planet-polluting sequins
They spend moments on the dancefloor and hundreds - if not thousands - of years in landfill. Is it time the festive favourites were outlawed

"On average, 8 million tonnes of plastic end up in our oceans every year, so we decided to take responsibility to prevent petroleum-based plastic being washed into waterways during the manufacturing and laundering of garments." Not only can washing a sequin dress cause microplastics to be swept into our oceans, but the production and processing methods required to make synthetic plastics are often environmentally damaging and, once in sequin form, can also produce toxic chemicals like carcinogens and hormone disruptors – not great when rubbing on bare skin.

Even if you wear a layer under your sequin maxi, never put it in the washing machine and wear it dutifully every Christmas for several years, once you do chuck it out, that sequin dress will sit in landfill for hundreds and hundreds of years. The reality is that the majority of sequin clothing has a short lifespan in our wardrobes and 1.7 million sequined items of clothing will end up in landfill after Christmas in the UK alone.

"Sequins are fabulous but, unfortunately, an environmental disaster," says Rachel Clowes, founder of The Sustainable Sequin company, a Future Fashion Factory-funded project setting out to perfect UK-manufactured, commercially viable **biodegradable sequins** made from renewable materials including waste and by-products. The aim of her project, she says, is to create "maximum sparkle with minimum adverse environmental impacts; plastic-free sequins which look great, perform perfectly and biodegrade at end of life."

So this Christmas, rather than reaching for a sparkly new pair of sequinned trousers, why not consider something in jazzy metallic lurex or a beaded satin? There's nothing very festive about sequin minis piling up in landfill

Environment-Friendly (Non-Planet-Polluting) Sequins

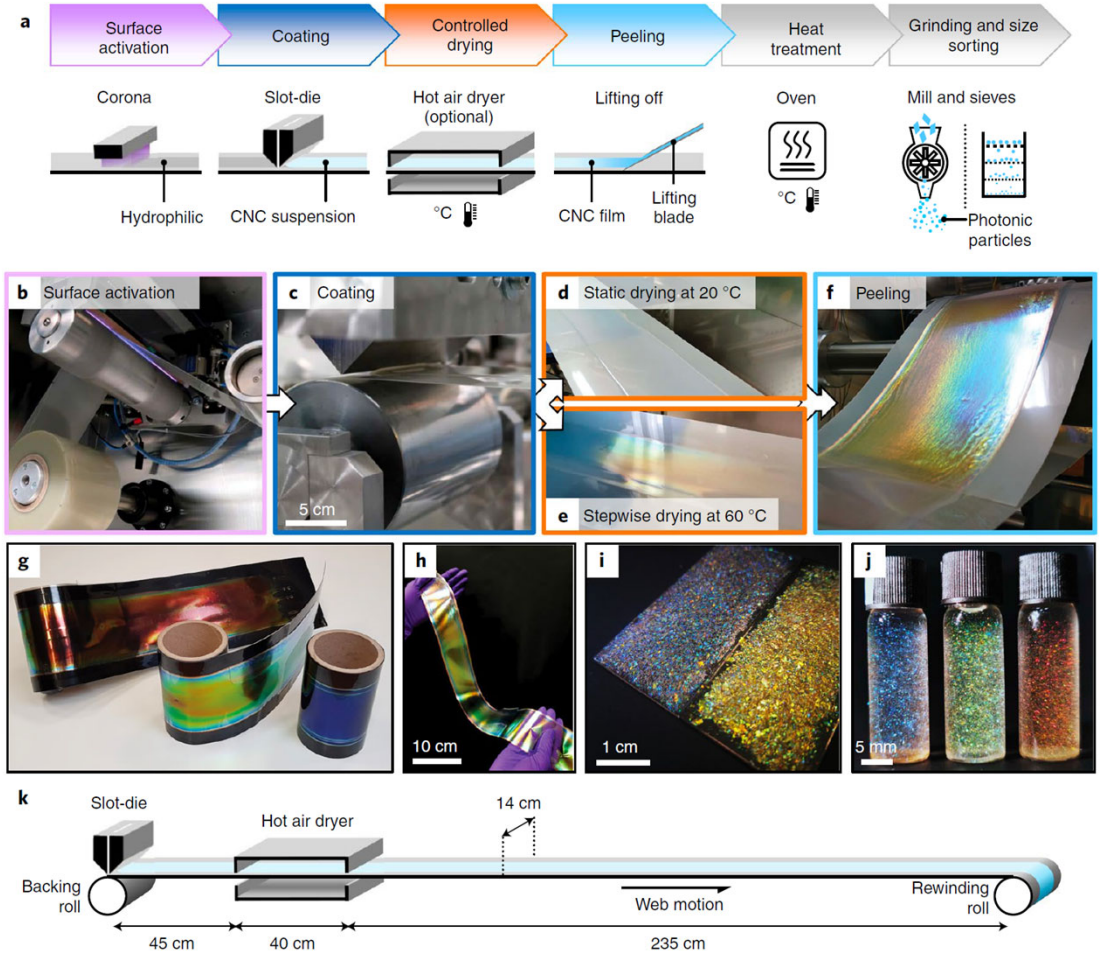


Fig. 1 | Overview of the roll-to-roll (R2R) processing of a cellulose nanocrystal (CNC) suspension into photonic films and microparticles.

a, Flow chart describing the key steps to prepare photonic CNC particles. b, Photograph of the corona etching step conducted after unwinding the the hydrophobic polyethylene terephthalate (PET)web (polymer substrate).

c, Photograph of the slot-die depositing the CNC suspension onto the central region of the PET web.

d, Photograph of a CNC suspension on the R2R web drying statically at room temperature.

e, Photograph of a near-dry CNC film on the R2R web after passing through an in-line hot air dryer, with the web moving in a stepwise continuous manner.

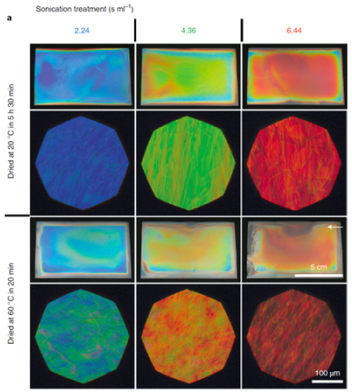
f, In-line peeling of a thick CNC film from the PET web.

g, Red, green and blue R2R-cast CNC films deposited onto a black PET web.

h, Free-standing R2R-cast CNC film. i, Pristine (left) and heat-treated (right) photonic CNC particles embedded in transparent varnish (prior to size sorting).

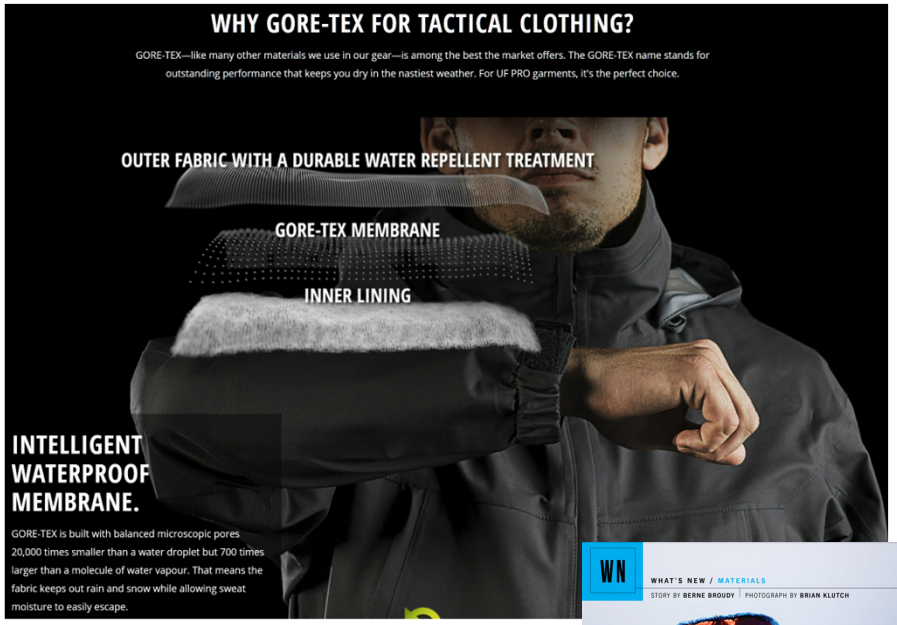
j, Heat-treated photonic CNC particles that can be used as effect pigments, after size sorting and immersion, from left to right, in ethanol, 50% aqueous ethanol and water.

k, Schematic of the R2R pathway, showing the position of the hot air dryer relative to the slot-die and the available length for static drying (lR2R = 3.2 m). For reference, in b–g the width of the web is 14 cm.



Droguet 2021, Large-scale fabrication of structurally coloured cellulose nanocrystal films and effect pigments

Tactical Clothing: Gore-Tex

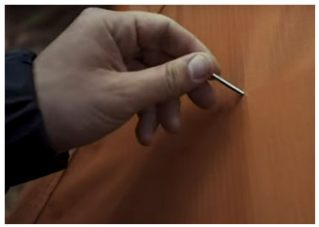


https://ufpro.com/us/gore-tex-tactical-clothing?gclid=EAIaIQobChMI8rnw7Zvz8gIVlKXICh1oYwceEAAYASAAEgLMs_D_BwE

Self-Healing Fabric

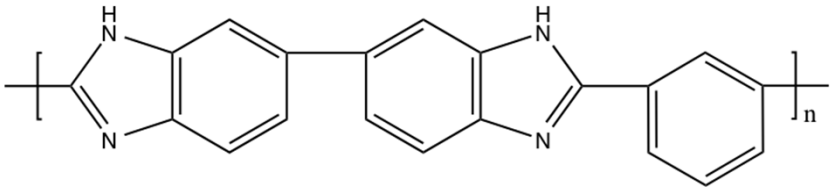
The nylon or any other fabric is coated with silicone.
The rubbing and heat makes the silicone to move to fill the hole.

Self-Repairing Nylon, Imperial Motion's New Nano Cure Tech Project.



https://www.visualatelier8.com/fashion/self-repairing-nylon-imperial-motions-new-nano-cure-tech-project

Polybenzimidazole (PBI)



poly[2,2’-(m-phenylen)-5,5’-bisbenzimidazole]

Polybenzimidazole is the best engineering thermoplastic on the market. It has **the strongest heat resistance and mechanical property retention of any unfilled plastic at temperatures above 400° F.** It outperforms any other reinforced or unreinforced engineering plastic in terms of wear resistance and load bearing capacity at severe temperatures. Polybenzimidazole is a highly clean unreinforced material in terms of ionic impurity, and it does not outgas anything but water. Polybenzimidazole's characteristics make it very appealing to semiconductor makers for vacuum chamber applications. Poly benzimidazole has good ultrasonic transparency, making it a great choice for ultrasonic measurement equipment parts such probe-tip lenses. Polybenzimidazole is a good thermal insulator as well. Polybenzimidazole does not cling to other polymers in the melt. Polybenzimidazole is suitable for contact seals and insulator bushings in plastic manufacturing and molding equipment because of these properties.

The most notable PBI properties include:

- Chemical resistance is high.
- Will not burn if exposed to air.
- There is no melting point, and it does not drop.
- When exposed to intense heat, characteristics must be maintained.
- Soluble in dimethylacetamide.

https://lairdplastics.com/resources/what-is-polybenzimidazole-pbi/

Space-age Suits & Firefighter Suits

In the 1950s, Dr. Carl Marvel developed a temperature-resistant artificial fabric for the U.S. Air Force called polybenzimidazole (PBI). PBI is an artificial fabric capable of remaining stable even in extreme heat and cold. In 1963, NASA recognized the usefulness of this material for its astronauts and joined forces with the U.S. Air Force, DuPont and Hoechst Celanese for further research and development [source: Olabisi, NASA Spinoff].

In recognition of how this ongoing research could help firefighters, the International Association of Fire Fighters (IAFF) in 1971 collaborated with NASA in Project FIRES (Firefighter Integrated Response Equipment System), a coordinated effort to leverage PBI and other technology developed for astronauts. This partnership led to better protective suit fabrics and international standards that help firefighters stay as safe as possible while in harm's way. These standards later became codified in the National Fire Protection Association's official standards for Personal Protective Equipment (PPE), and they continue to help protect firefighters by ensuring that the suits they wear when fighting fires conform to tough specifications [source: IAFF].

https://science.howstuffworks.com/innovation/nasa-inventions/nasa-save-firefighters.htm

Jackets using Aerogel

Withstand temperatures from -50 °C to 1,600 °C

$2,700. www.n9ve.com

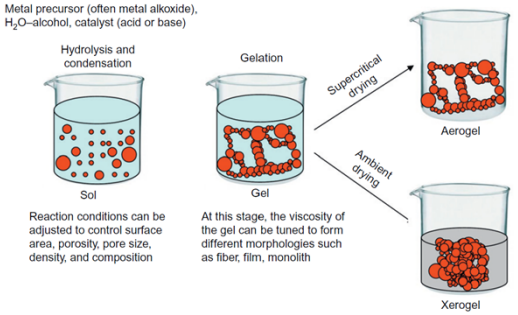
http://spinoff.nasa.gov/spinoff2001/ch5.html

Quota Zero Jacket

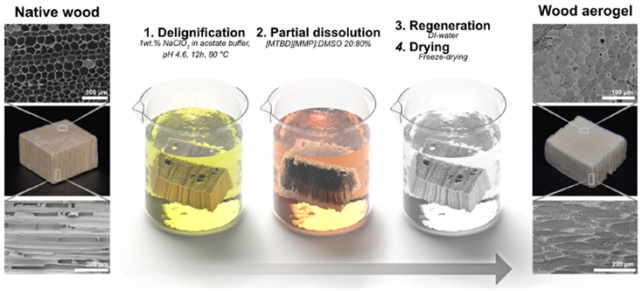
Aerogel Design System

This second type of padding, which also offers extraordinary thermal performance, is made with one of the most insulating materials in the world, namely Aerogel. Breathable and light, this padding makes it possible to maintain body temperature. The mesoporous structure of the aerogel allows humidity produced by the body to be released gradually to the exterior. Certain parts of the interior of the garment have been identified as needing to provide maximum controlled body temperature, and thus have been covered with anatomically shaped Aerogel patches.

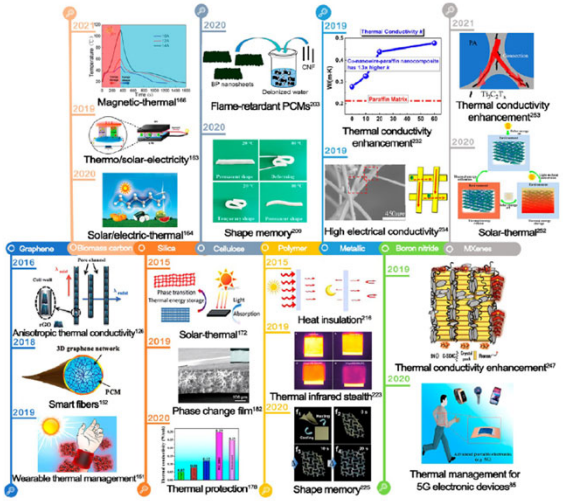
http://www.gzespace.com/gzenew/index.php?pg=qzerojacket



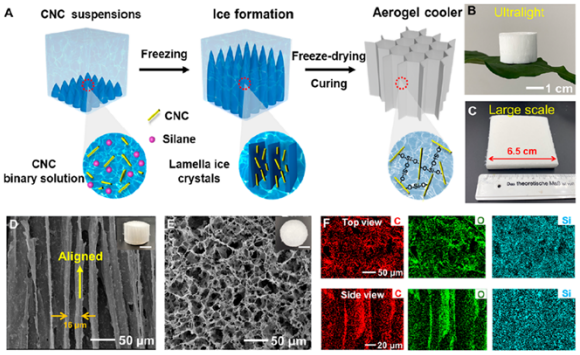
Tüysüz 2012, Ordered mesoporous materials as catalysts



Garemark 2022, Nanostructurally controllable strong wood aerogel toward efficient thermal insulation



Liu 2022, Aerogels meet phase change materials- Fundamentals, advances, and beyond



Cai 2022, Dynamically tunable all-weather daytime cellulose aerogel radiative supercooler for energy-saving building

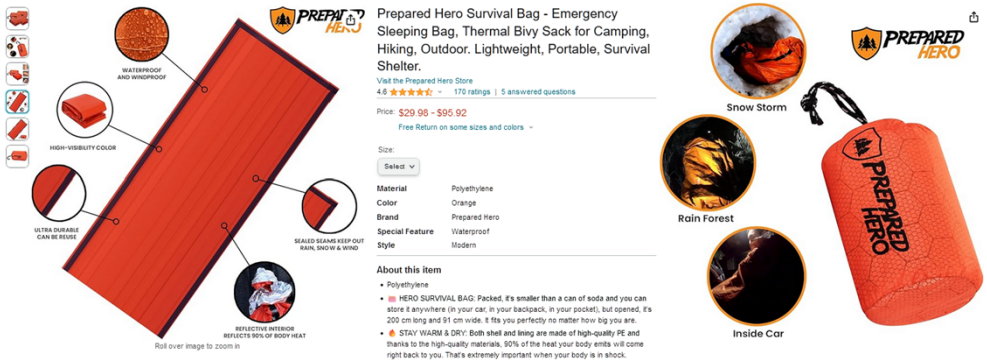
Protection from Extreme Cold

Keeps 90% of Your Body Heat
The shell and lining of this survival bag are made of durable and flexible PE (polyethylene)

Stop Hypothermia: Wearing it reflects 90% of heat back to you, preventing hypothermia in freezing weather.

100% waterproof and windproof, built for the most extreme weather scenarios.

https://preparedhero.com/blogs/articles/guide-to-the-hero-survival-bag



https://www.amazon.com/Prepared-Hero-Survival-Bag-Lightweight/dp/B09QLQ5HRZ?th=1

Plastic bags for prevention of hypothermia in preterm and low birth weight infants

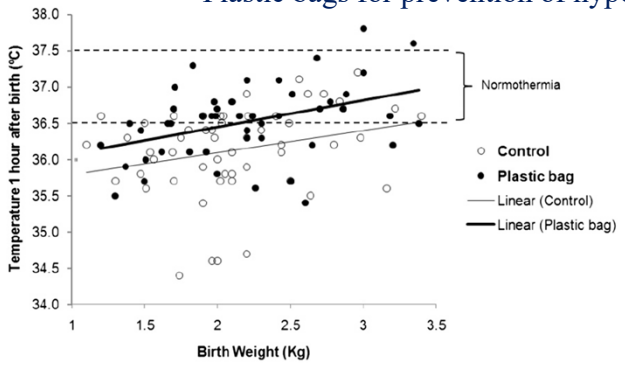


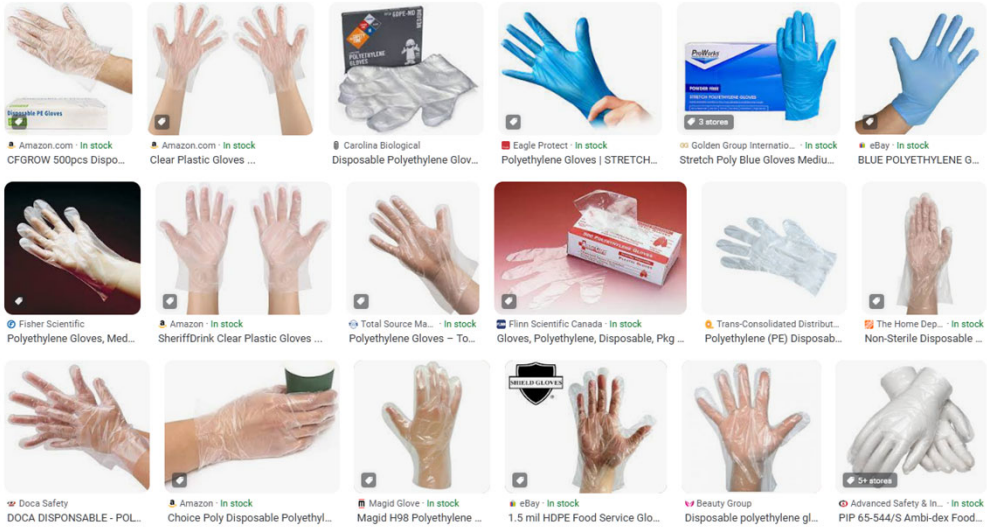
FIGURE 2
Temperature 1 hour after birth in infants randomized to a plastic bag or control group plotted by birth weight. The dotted lines are the limits of normothermia. More infants randomized to a plastic bag compared with control infants had normal temperatures. The effect happened across the birth weight strata. Hyperthermia (>38°C) was not seen.

WHAT'S KNOWN ON THIS SUBJECT: Preterm neonates in resource-poor settings frequently develop hypothermia. Plastic bags or wraps are a low-cost intervention for the prevention of hypothermia in infants in developed countries.

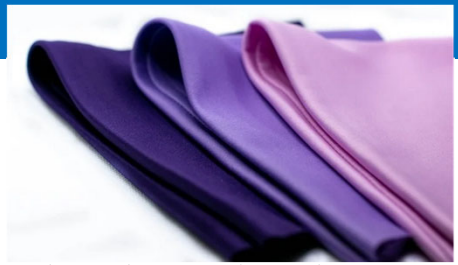
WHAT THIS STUDY ADDS: For preterm infants born in a resource-poor health facility, placement in a plastic bag at birth can reduce the incidence of hypothermia at 1 hour after birth.

Infants were placed inside a plastic bag (nonmedical low-cost [3 cents per bag] linear low-density polyethylene bag measuring 10x8x24 in. and 1.2 mil thick covering the trunk and extremities.
(1 mil = 1/1,000 inch = 0.0254 mm, 1.2 mil = 0.03 mm =30 μm)

Leadford 2013, Plastic bags for prevention of hypothermia in preterm and low birth weight infants



Overcoming Massive Hurdle in Textile Recycling



Although present in much of the clothing we wear on a daily basis, elastane is incredibly difficult to recycle. Researchers at the Vienna University of Technology (TU Wien) have uncovered a novel method to overcome these challenges, bringing the textile industry one step closer to its sustainability goals.

Why Is Elastane Recycling Important?

Elastane, otherwise known as Spandex or Lycra, can be found in tights, undergarments, and other clothing the world over. Derived from petroleum, the extraction and refining of this finite resource is a significant contributor to the textile industry's carbon footprint.

Whilst the polyurethane basis for these products allows for the stretchy and comfortable products that we are used to, this synthetic polymer fiber complicates the textile recycling process to a significant degree, meaning that these petroleum-based products are often abandoned in landfills.

Beginning in 2025, used and waste textiles across Europe are to be recycled as per new, wider-encompassing measures put in place by the European Union. Uncovering new and more efficient means of coping with waste textiles is essential, especially when it comes to mixed fibers.

Effective Separation of Elastane

Thermal decomposition methods alter the entire textile matrix, while shredding textiles can create bothersome strings of elastane in machines due to its stretchy nature. Therefore, the researchers considered a new approach: a non-hazardous solvent to dissolve the elastane that rivals the effectiveness of hazardous solvents employed in previous research. Six organic solvents were tested against one another in order to identify which was the most effective in dissolving elastane in mixed fabrics following effective identification. The researchers focused on polyester/elastane and polyamide/elastane textile waste when testing their solvents.

It was found that dimethyl sulfoxide (DMSO) was the most effective solvent that is scalable and environmentally friendly. They also identified that under current REACH regulations, it is not listed as having any classified hazards. Ultimate treatment temperatures were found to be 120 degrees Celsius in order to dissolve elastane in just ten minutes. Using DMSO, the researchers were able to recover not only elastane but the polyester and polyamide fibers for textile recycling and regeneration. Further, the DMSO itself could be recovered for further separations.

References and Further Reading

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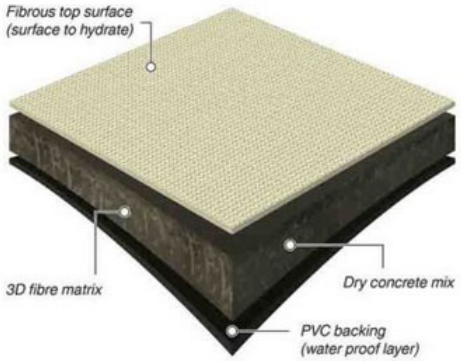
Polymers in Construction

Concrete Cloth

Concrete Cloth™ Roll

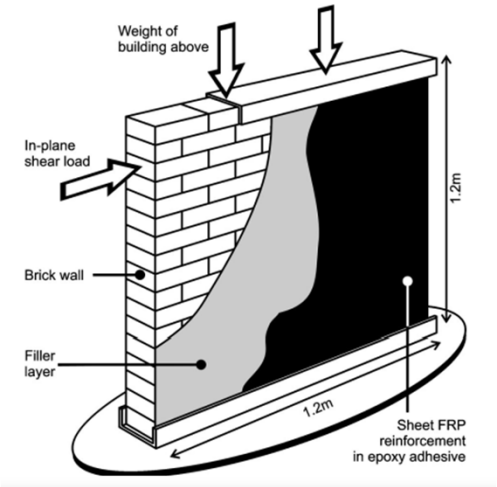
Concrete Cloth is a flexible concrete impregnated fabric that hardens upon hydration to form a durable concrete layer, protecting liner from digging animals, human traffic, or damage from setting large rocks or boulders. To avoid frustrating liner repairs, use Concrete Cloth on top of or beneath liners to prevent digging animals from chewing or clawing through the liner. When setting large rocks on top of liner, the material can be used as a protective barrier as these larger rocks are often difficult to move in case of a leak after installation. Water features in public or high traffic locations can also benefit from Concrete Cloth by protecting the liner from vandalism and children or animals walking over the feature. Concrete Cloth is extremely easy to install. Simply lay the matting in the desired location and saturate the top-side of the material using a garden hose or other source. The top surface fabric allows water to penetrate during hydration, and the bottom surface consists of a PVC membrane which acts as an impermeable barrier. The material can easily be cut to fit any installation using commonly available cutting tools, such as a utility knife. Each 3.375 ft wide by 30 ft long roll is 141 lbs and designed to be able to be lifted by two persons, making installation without machinery quick and easy. $784.08.
https://www.aquascapeinc.com/products/concrete-cloth-roll



Polystyrene Foam

Polystyrene foam blocks with reenforced concrete

Polymers Against Earthquake



Earthquake protection of masonry shear walls using fibre reinforced polymer strengthening. C. Konthesingha, Konthesingha Muhandiramlage (2012)
https://www.semanticscholar.org/paper/Earthquake-protection-of-masonry-shear-walls-using-Konthesingha-Muhandiramlage/86357e6930282c0be81b0dcd22dc9dca493990d2

Glass fiber-reinforced polymer (GFRP), formed by glass fibers bonded in a matrix made of vinyl ester, has been employed extensively in a number of rehabilitation applications, particularly seismic retrofitting. Seismic retrofitting is a technique to modify the existing concrete structures to make them protected against soil failure and seismic activities. The immunity to corrosion, high strength-to-weight-ratio, and convenient handling and installation make fiberglass rebar a material of choice in a large number of projects where inelastic deformation capacity and high strength are the prerequisites.
https://www.tuf-bar.com/how-is-frp-the-best-earthquake-resistant-material/

Polymer shock blocks protect against earthquakes in Australia
The custom-fabricated high density polyethylene PE100 blocks, produced by Hercules Engineering, are used as sacrificial elements so concrete components will remain preserved instead of grinding on one-another
https://www.safetysolutions.net.au/content/materials-handling/case-study/polymer-shock-blocks-protect-against-earthquakes-in-australia-172509130

Clay Brick with straws

Figure 1. Limited work area for installation of **Fiber Reinforced Polymers (FRP)** for tension loads. The most commonly used fibers are glass and carbon.
https://www.radyab.co/en/blog/seismic-retrofit-with-fiber-reinforced-polymers/

For their modern take on rolling seismic isolation, detailed in Frontiers in Built Environment, the researchers injected cementlike mixes into hundreds of balls from nearby tennis clubs that had lost their bounce. They built an inexpensive prototype consisting of four filled tennis balls sandwiched between two concrete slabs, and they found that it withstood simulated earthquake shaking while supporting eight kilonewtons of force per ball—about twice what isolation systems might experience under one-story houses. The balls had to contain precisely the right amount of the mixture (the researchers used a pastry bag to fill them) to dampen vibrations without cracking during tests. (Scientific American. January 2022)

Carbon fiber layers on both sides of an object.
They stretch and then return to the original state.

https://www.seequent.com/engineering-buildings-which-resist-seismic-disturbance/

Fiber-Reinforced Polymer Composites

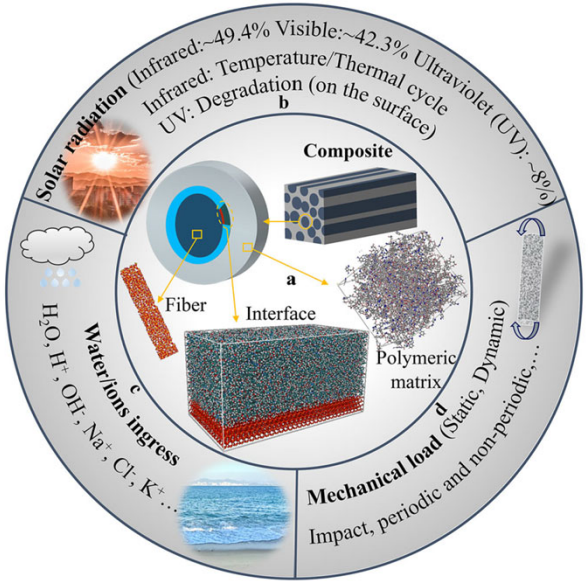


Fig. 2 Representative service environments for FRP composites. A. Schematic diagram of the microstructural components of FRP composites. Representative service environments: b solar radiation, c water/ions ingress, and d mechanical load.

Table 1 General characteristics of nonbonding interactions and covalent bonds.

Type of force	Strength (kcal/mol)	Distance (nm)
Van der Waals	< 1	0.3–0.6
Hydrogen Bonds	1 ~ 40	~ 0.3
Covalent Bonds	> 40	0.074–0.267

Lin 2023, Multiscale mechanics and molecular dynamics simulations of the durability of fiber-reinforced polymer composites

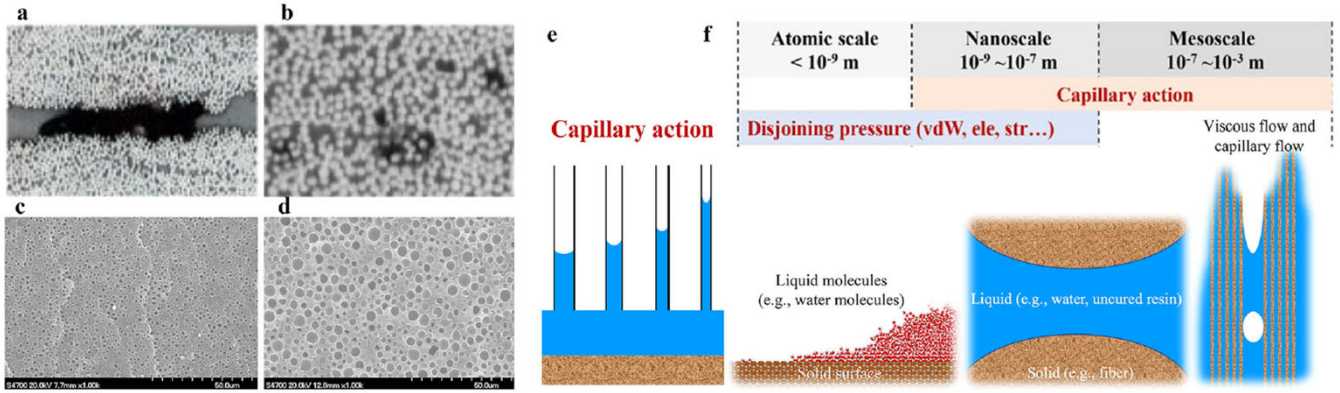


Fig. 4 Voids/pores in composites and capillary action. Void formation in liquid composite molding processes: **a** Image of the void between tows in a resin transfer molding part; **b** Image of voids inside the tow in a resin transfer molding part. SEM images of porous epoxy monoliths after curing, with different solvent concentrations: **c** 30 wt%, and **d** 40 wt%. **e** A schematic of the capillary phenomenon. **f** The scope of scales applicable to capillary action and disjoining pressure.

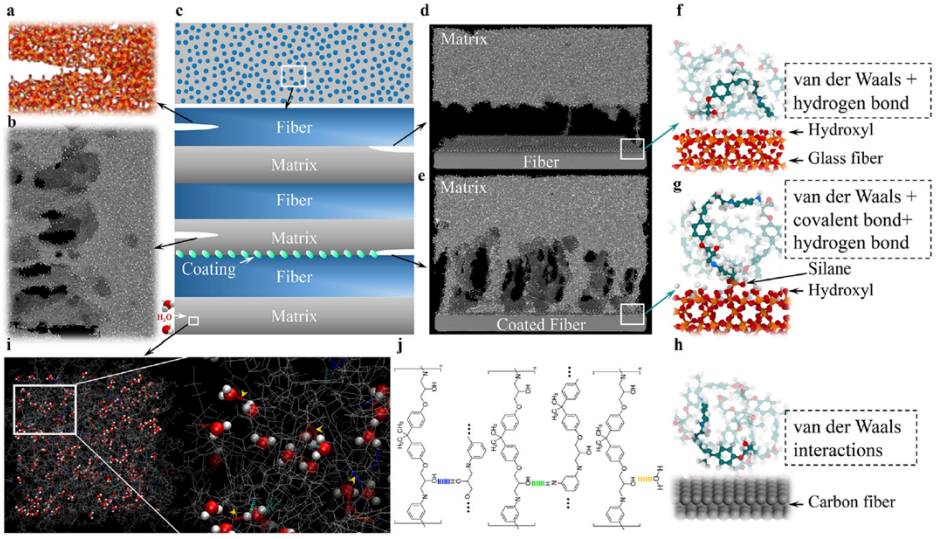


Fig. 5 Typical modes of destruction in FRP composites and microscopic damage mechanisms. **a–e** Typical modes of destruction in FRP composites: Fracture in fiber (**a**) and matrix (**b**); **c** Schematic diagram at the mesoscale; Debonding of uncoated fiber-matrix interface (**d**) and coated fiber-matrix interface (**e**). **f** Van der Waals interaction and hydrogen bond between the polymer and the hydroxylated surface of silica. **g** Silane coupling agent bonds fiber and matrix by forming covalent bonds. **h** Van der Waals interaction between polymer chain and carbon fiber. **i** Water molecules enter the matrix; j Hydrogen bond between the hydroxyl groups of the polymer chain O–H O (blue); Hydrogen bond between the hydroxyl and amino O–H N (green); Hydrogen bond between the water and hydroxyl of the polymer chain O–H O (yellow).

Unbreakable Glass Windows

Martin 2020, Polymeric interlayer materials for laminated glass

https://www.seequent.com/engineering-buildings-which-resist-seismic-disturbance/

Unbreakable glass can be classified into two primary types:

Laminated glass windows: A specialized type of security window designed with a thin piece of transparent film that's sandwiched between two panes of normal glass, also known as shatterproof glass.

Polycarbonate window panels: Flexible and high-strength panels that look just like regular window glass, but they are actually made of a combination of acrylics, polycarbonate, and other plastic.

Both of these widely-known types of "unbreakable glass" are far more durable and lightweight than normal glass windows, but they're not created equally.

Laminated Glass (aka "Shatterproof Glass")

In the window industry, unbreakable laminated glass is often tossed around as "shatterproof glass." This has become a catch-all term that vaguely defines a certain variety of laminated security glass products. However, this term can be a bit misleading because most shatterproof laminated security glass is not 100% unbreakable.

Polycarbonate Panels

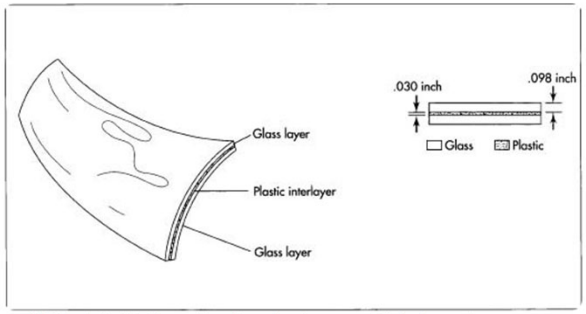
If you're interested in unbreakable glass that truly lives up to its name, polycarbonate panels are the type you want. Polycarbonate panels are significantly more difficult to break than both standard glass windows and laminated glass mentioned above. Compared to these latter options, polycarbonate panels deliver superior protection against forced entry attempts, burglaries, and weather-related disasters.

Although these panels look and function like glass windows, they are made of a combination of polycarbonate, acrylics, and other plastic resins. The combined strength and durability of its material composition makes polycarbonate panels a truly unbreakable and impenetrable solution.

While a laminated glass or shatterproof windows can effectively delay forced entry attempts, a polycarbonate window will always maintain its integrity against the most relentless and aggressive of attacks, including bomb blasts. Some polycarbonate panels have been engineered for ballistic protection, which provides protection against firearm threats.

http://www.madehow.com/Volume-1/Automobile-Windshield.html

New types of laminated-glass windshields are being researched. A bi-layer windshield has been developed that only requires one outer sheet of glass, .08 to .16 of an inch (2-4 millimeters) thick, joined to a .254 of an inch (1 millimeter) sheet of polyurethane. The polyurethane sheet consists of two layers, one having high absorption properties and the other high surface resistance. Unique features of this bi-layer windshield include ultraviolet resistance, self-healing of scratches, weight savings, more complex shapes, increased safety due to retention of glass splinters, and anti-fog capability.



A finished windshield consists of two glass layers sandwiched around a plastic interlayer. Although very thin—about .25 inch thick—such laminated glass is very strong and is less likely to shatter than normal safety glass. In the United States, windshields are required by law to be made of laminated glass.

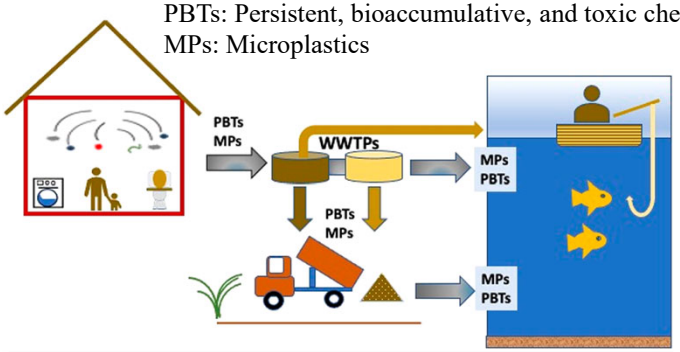
Laminated glass (LG) is a type of safety glass that holds together when shattered. In the event of breaking, it is held in place by a thin polymer interlayer, typically of polyvinyl butyral (PVB), ethylene-vinyl acetate (EVA), lonoplast polymers, cast in place (CIP) liquid resin, or thermoplastic polyurethane (TPU), between its two or more layers of glass.[1] The interlayer, made through heat and pressure, keeps the layers of glass bonded even when broken, and its high strength prevents the glass from breaking up into large sharp pieces.[1] This produces a characteristic "spider web" cracking pattern when the impact is not enough to completely pierce the glass. The thermoset EVA offers a complete bonding (cross-linking) with the material whether it is glass, polycarbonate, PC, or other types of products.

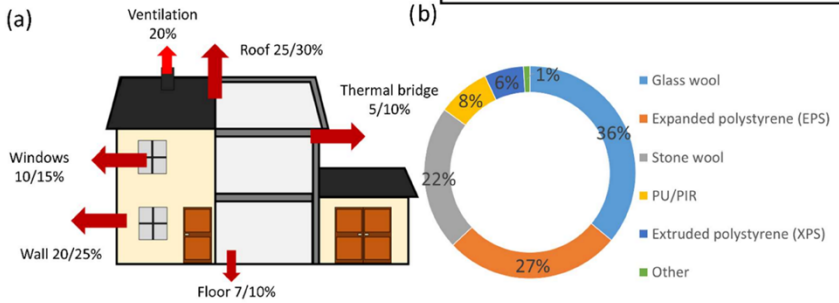
https://en.wikipedia.org/wiki/Laminated_glass

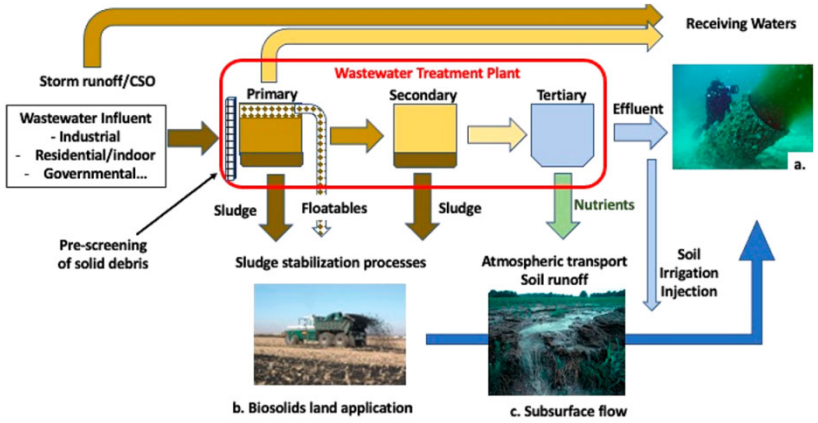
Durable Plastic Goods Used in Houses

The global plastic toxicity debt: The continuous supply and persistence of microplastics and polymer additives ensure that effects on human and environmental health will be long-term and increasing as plastics fragment and additives become more bioaccessible.

PBTs: Persistent, bioaccumulative, and toxic chemical additives
MPs: Microplastics



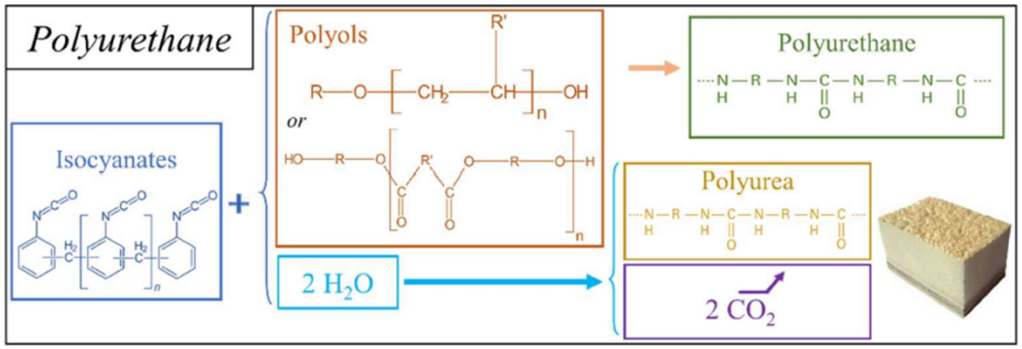




Hale 2022, Durable plastic goods- A source of microplastics and chemical additives in the built and natural environments

Examples of PUR foam applications, such as the thermal insulation of buildings, different polymeric devices, and thermal insulation of pipes.

(a) Heat losses for a standard building in France,
(b) European insulation market in 2019.



Reaction diagram for polyurethane (PUR) and polyurea (PUA) systems, containing (from left to right) the isocyanate precursors, some examples of polyols for the formation of PUR, and, in the presence of water, the formation of PUA and the consequent liberation of CO_2.

Borrero-López 2022, A review of rigid polymeric cellular foams and their greener tannin-based alternatives

PolyLevel: Foundation Repair

IN THE KNOW. by yahoo!

https://www.intheknow.com/post/joel-bervell-tiktok...

The PolyLevel® System is a state-of-the-art approach to repairing sunken concrete slabs, such as sidewalks, driveways, patios, pool apron decks, garage aprons, and basement slabs. It takes the original concept of mudjacking (slabjacking) and combines it with modern knowledge and technology. Rather than using a mixture of concrete and mud, PolyLevel® utilizes high-density, expanding polyurethane foam to raise slabs back to a desired level.

Strong but light: PolyLevel® weighs only about 4lbs. per cubic ft., compared to 120lbs. per cubic ft. for standard fill material.

Waterproof: Once cured, PolyLevel® will not wash away.

Quick curing. Downtime is minimized with PolyLevel® concrete repair. Full loading of the foundation, roadway, or other structural element can usually happen about 15 minutes after the material is injected.

Adjustable: Adjusting the density and expansive force of the 2-part foam affords a wide range of geotechnical uses. Lifting force can be adjusted by fine-tuning the chemical reaction that causes the foam to expand. An experienced applicator can factor not only the weight of the structural element but also soil characteristics and temperature and weather conditions. Special formulations are possible for applications where water must be displaced.

The PolyLevel® System utilizes high-density polyurethane foam to stabilize and level concrete floors and foundations.

https://www.polylevel.com/concrete-leveling-products/polylevel-system.html
https://www.golevelup.com/concrete-leveling/polylevel-injection.html

Polymeric Wood

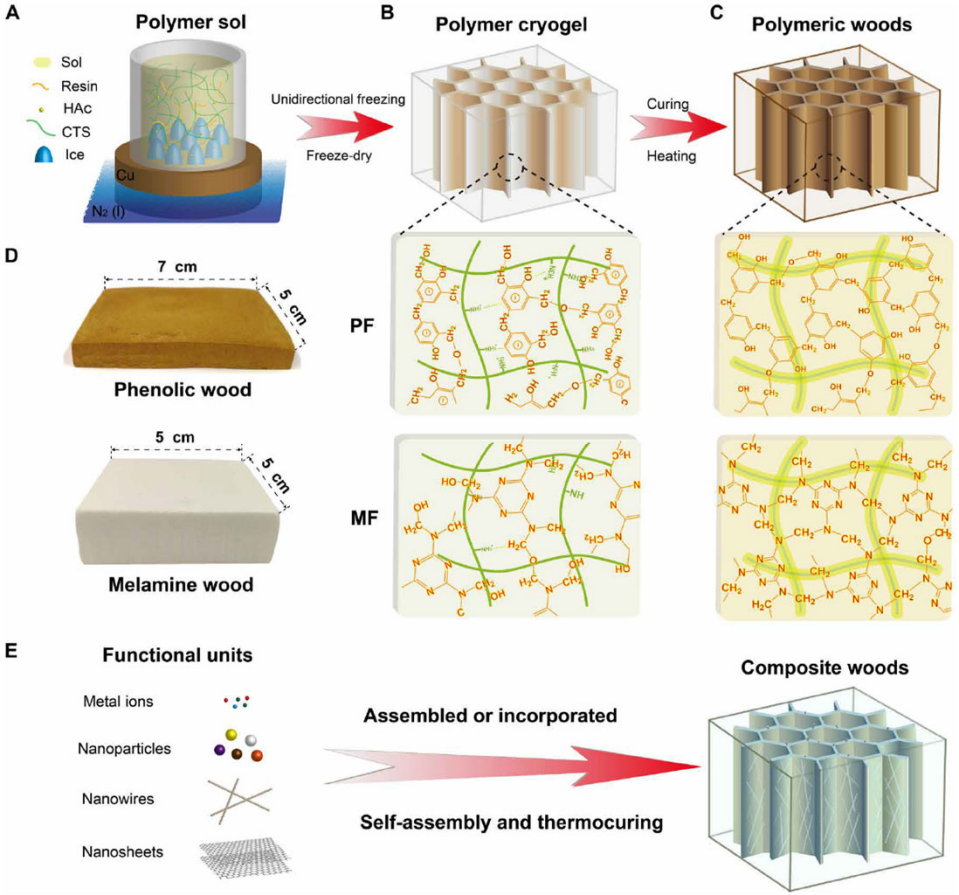


Fig. 1. Fabrication scheme of the bioinspired polymeric woods and kinds of composite woods based on PF and MF. (A) Starting solution (sol) including water-soluble thermoset resins, CTS, and acetic acid (HAc), forming a homogeneous polymer solution. (B) Predesigned matrix prepared by the ice template–induced self-assembly and freeze-drying process. (C) Final polymeric woods after thermocuring the predesigned matrix. The resins are completely cross-linked. (D) Photographs of the artificial polymeric woods based on phenolic resin (top, cellular CPF-4-5) and melamine resin (bottom, CMF-3-5). (E) Scheme illustration showing the fabrication of various composite woods by adding ions or functional nanomaterials into the polymer solution, followed by the above self-assembly and thermocuring process.

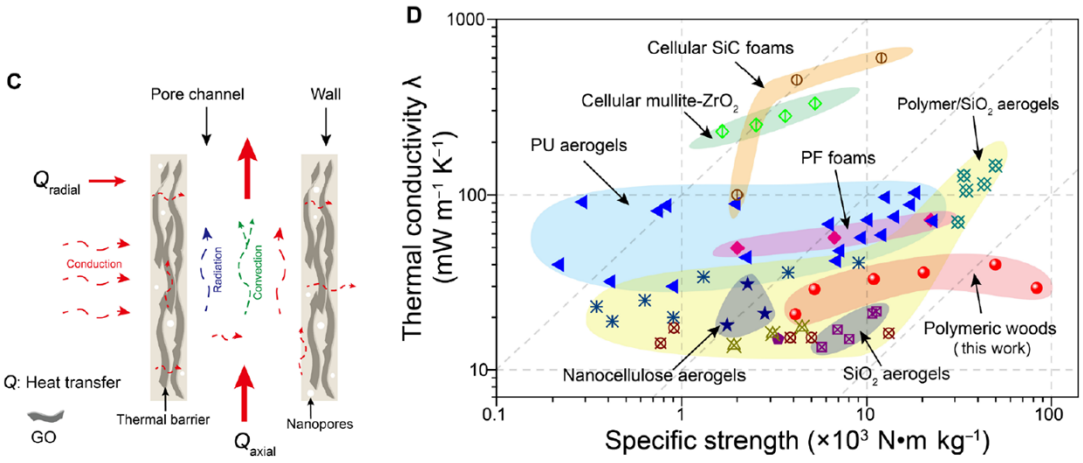
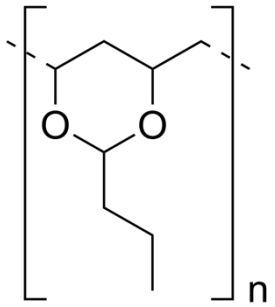


Fig. 4. Corrosion resistance and thermal conductivities of polymeric woods. (C) Schematic illustration showing the difference of thermal conductivity in the radial and axial directions. (D) Thermal conductivity versus specific strength for polymeric woods, traditional aerogel-like materials, and other cellular ceramic materials.

Yu 2018, Bioinspired polymeric woods

Inoplast

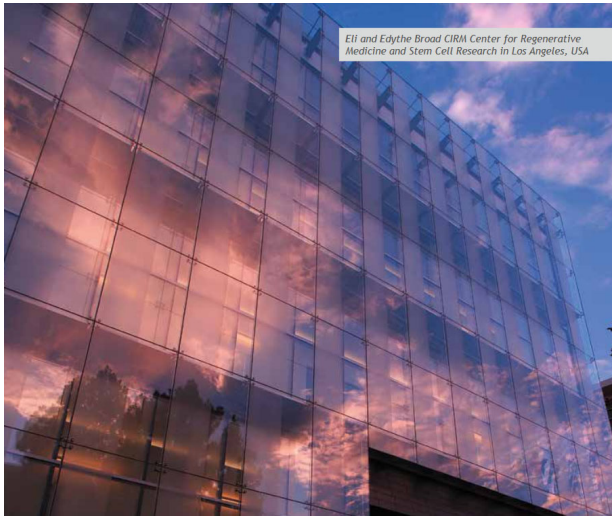
Laminated glass windows have been proved effective for mitigating glass fragment threats
as compared to the monolithic glass windows [2–7]. The most commonly used interlayer material for laminated glass, polyvinyl butyral (PVB), is soft, very ductile and exhibits viscoelastic material properties. After glass breakage, PVB interlayer will stick the shattered glass fragments together therefore prevent them from flying into the room. The interlayer material with large ductility will continue to deform and dissipate the imposed energy. However, due to the limited stiffness and strength of PVB, laminated glass with PVB interlayer offers relatively poor residual load-carrying capacity after glass breakage [8].
X. Zhang, Y. Shi, H. Hao, J. Cui. The mechanical properties of ionoplast interlayer material at high strain rates. Materials & Design, 83 (2015) 387-399.



Poly(vinyl butyral) = Poly[(2-propyl-1,3-dioxane-4,6-diyl)methylene]

The Pilkington Planar™ |SentryGlas® ionoplast interlayer system represents the latest advance in frameless glazing, providing architects, designers, glazing contractors and building owners with enhanced strength, safety, security and durability. This system further expands the possibilities for structural glazing systems in the most demanding architectural glass applications, while still maintaining the elegance of design and detailing.

https://www.trosifol.com/fileadmin/user_upload/Pilkington_planar_E_A4_neu.pdf



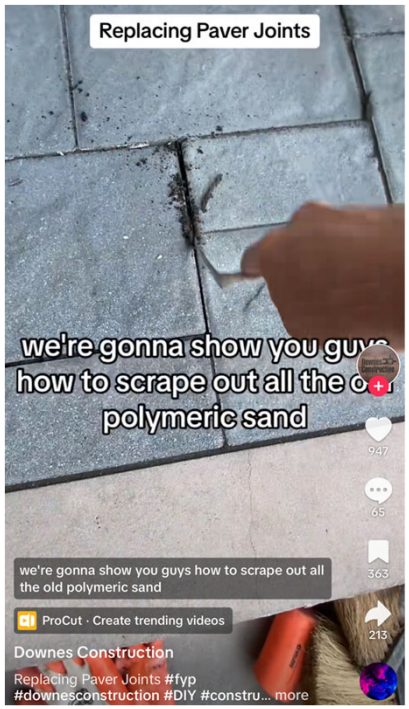
The world's first revolving glass floor When renovation of Seattle's iconic Space Needle began, its managers were myopic: all they wanted was better views. So they added 176 tons of glass—37 of them to turn the lower deck's revolving floor transparent. The new bottom, called the Loupe, consists of 10 glass layers—four that stay put and six that spin on 48 visible motorized rollers. Sheets of a stiff laminating plastic called "ionoplast"m (Stiff Poly(vinyl butyral) (PVB)) keep any cracks from propagating. The floor lets visitors peer 500 feet straight down.

John Lok and Space Needle LLC
https://www.popsci.com/best-engineering-innovations-2018?CMPID=ene120218#page-2

Polymeric Sand

Polymeric sand is a material (consisting of various grades of masonry silica sand and a blend of polymers) used to fill paver joints, the empty spaces found between each paver, tile or natural stone. It is sometimes called jointing sand, paver sand or hardscape sand. Jointing sand is made up of fine grains, to which manufacturers add a mixture of specific additive particles. When put in contact with water, this substance acts as an ultra-powerful bonding agent that strongly binds together concrete elements. Polymeric sand is appreciated by paver installers because joints you get from it are durable and even . This eliminates any risk of weed growth and ant infestation that could affect the overall aesthetics and durability of paver projects.

https://techniseal.com/pro_en_us/why-choose-polymeric-sand-for-paver-jointing)
https://unilock.com/articles/what-is-polymeric-sand-and-how-is-it-used-for-locking-patio-pavers-yorktown-heights-ny/
https://blackdiamondcoatings.com/blogs/resources-blog/what-is-polymeric-sand
https://www.dirtglue.com/index.php/our-products/dirtgluedrypowdered-polymer
https://www.corrosionx.com/products/ground-glue-dust-and-gravel?variant=42548079755509



Types of water based adhesives

There are four main types of water based adhesives: vegetable glues, animal/protein glues, resin cements, and latex cements.

Latex Adhesives: Latex cements, another group of water based adhesives, are made from emulsified elastomers, or rubbers. Like polymer adhesives, latex adhesives must be applied to the substrate surface and allowed to dry into either a solid bond, or a more crude, flexible bond, depending on the formulation. These types of water based adhesives are primarily used for bonding stamps, envelopes, fabric, leather, and wood.

Resin/Polymer Adhesives: The primary components in resin water based adhesives are vinyl acetate, ethylene vinyl acetate, and acrylic resin emulsion polymers. Emulsions are mixes of liquids that cannot really be blended. To make these kinds of water based adhesives, water is mixed with the polymers polyvinyl acetate (PVA) and ethylene vinyl acetate (EVA) to produce a bright white liquid mixture. Once the adhesive has been applied and allowed to dry, however, it produces a clear, flexible bond that is also used for paper, but also for wood and plastic.

Dextrin Adhesives: Vegetable adhesives are one of the more popular water based adhesives types. These adhesives contain a starch base and result in a more frail finish. For that reason they are commonly used for in the paper industry for such applications as bookbinding. These adhesives are known to be very durable when used with material like paper, but their vegetable base does make them more susceptible to breakdown when exposed to water.

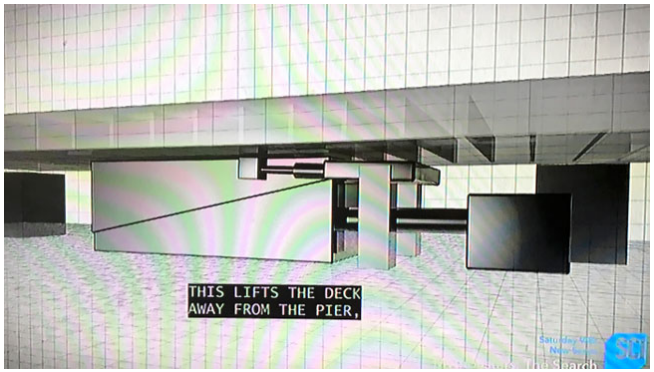
Caesin Adhesives: Animal, or protein adhesives are derived from either animal organs that are processed specifically for the purpose of making hot glue, or from proteins found in animal milk, which is used to make casein glue. While hot animal glue is primarily for quick-fix/quick-set applications, casein glue, which is more resistant to water and moisture, is used primarily in the beer and wine bottling industry.

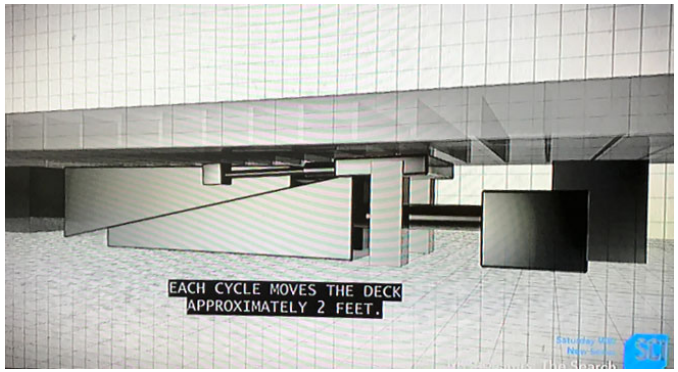
https://www.simalfa.com/lp/water-based-adhesives

Guerro 2010, Joint filling composition

Impossible Engineering: The Millau Viaduct Bridge

1. Millau Viaduct, France – 343 meters (1,125 ft) tall. Opened in 2004, this 4 lanes bridge is a cable-stayed bridge that spans the valley of the River Tarn near Millau in southern France. The bridge has 7 piers of different heights.





http://www.twofour.co.uk/news/impossible-engineering-the-milau-viaduct/

Biodegradable Materials in Building and Construction?

Industries around the globe are reevaluating their practices to incorporate environmentally friendly materials for a sustainable future. Traditionally, construction has been associated with resource-intensive processes and materials that contribute to environmental degradation, but biodegradable materials are revolutionizing building and construction in this regard.

How Biodegradable Materials are Used

Biodegradable materials are designed to break down naturally over time, reducing the environmental impact associated with traditional construction materials. For instance, normal plastic is dangerous for the environment since it does not decompose for a very long time; however, biodegradable polymers derived from natural sources, such as cornstarch or sugarcane, can be used to create biodegradable plastics, which, over time, break down into harmless byproducts, reducing the amount of waste produced.

These plastics can be employed in various construction applications, including packaging, insulation, and temporary structures. Similarly, researchers are exploring biodegradable concrete alternatives to reduce the environmental impact of traditional concrete production, which is a significant source of carbon dioxide emissions.

Challenges

The durability of biodegradable materials in diverse climatic conditions and their cost-effectiveness compared to traditional counterparts are big challenges. The cost of biodegradable materials, at present, can be a deterrent against widespread adoption. Government incentives and policies promoting sustainable construction practices could play a crucial role in making biodegradable materials more economically viable.

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https://www.azobuild.com/article.aspx?ArticleID=8654&utm_source=azonetwork_newsletter&utm_medium=email&utm_campaign=clean_technology_newsletter_10_january_2024

Polymers in Foods & Utensils

Disposable Cutlery & Tableware

Cutlery, plates and cups are next in war on plastic waste

Fuyit 250Pcs Disposable Dinnerware Set, Compostable Sugarcane Cutlery Eco Friendly Tableware Includes 50 Biodegradable Paper Plates, Forks, Knives and Spoons for Party, Camping, Picnic, BBQ (White)

by Fuyit

148 ratings | 17 answered questions

Price: $33.99 & FREE Shipping. Details & FREE Returns

https://www.thetimes.co.uk/article/cutlery-plates-and-cups-are-next-in-war-on-plastic-waste-2fz6x05vr

https://www.amazon.com/Fuyit-Disposable-Compostable-Eco-Friendly-Biodegradable/dp/B07SJQMYBT

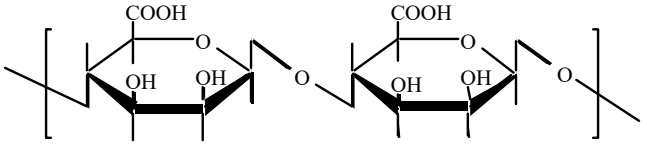
Disposable Cutlery & Tableware

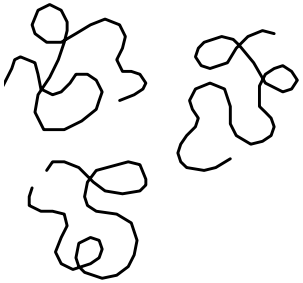
Polyethylene terephthalate (PET)

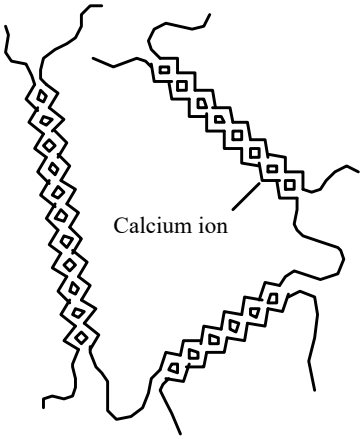
Packets, pouches, or sachets

Polyethylene

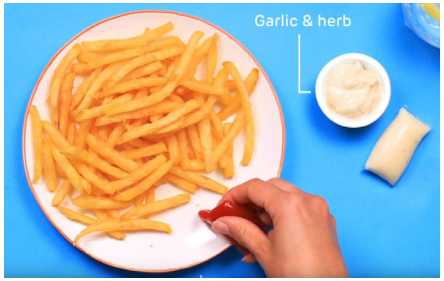
Alginic acid





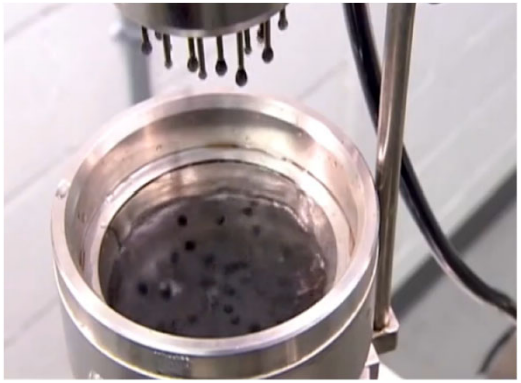


Compostable seaweed based sauce sachets

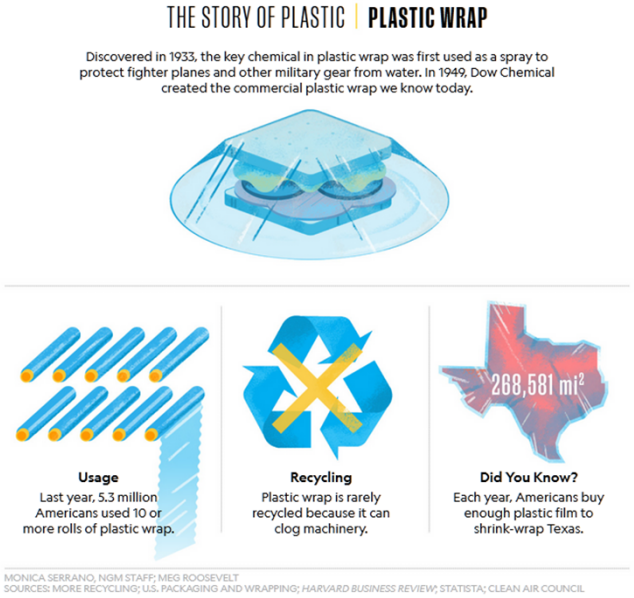


https://www.justeatplc.com/news-and-media/press-releases/just-eat-trials-worlds-first-seaweed-based-sauce-sachets-reduce-impact-plastics-takeaway-sector

Vegan Caviar



Food Containers



https://www.nationalgeographic.com/environment/article/story-of-plastic-sticky-problem-of-plastic-wrap?cmpid=org=ngp::mc=crm-email::src=ngp::cmp=editorial::add=SpecialEdition_20211105::rid=FF526C1F1B0738788B420FE1D0034350

Stretchable Silicone wrap

https://trystretchandfresh.com/
https://www.youtube.com/watch?v=GFj56OgWDpY

Unbreakable Bottles

No leaching of plastic plasticizers. But plastic pollution continues.
Until now, parents have had to make a choice when it comes to bottles: Glass or plastic? Glass can be heated without leaching chemicals and is easier to clean, but plastic is lighter and more durable. The ChiccoDuo Hybrid features the best of both, with a thin layer of unbreakable glass bonded to an outer plastic layer. "Liquid only touches glass inside, but the bottle feels like plastic," says Brenda Liistro, a general manager at Artsana, Chicco's parent company. The Hybrid bottle ($20 for two) is now available after its launch was delayed when the technology was used to make vials for Moderna's COVID-19 vaccine. (by Jesse Will)

Dietary Fiber

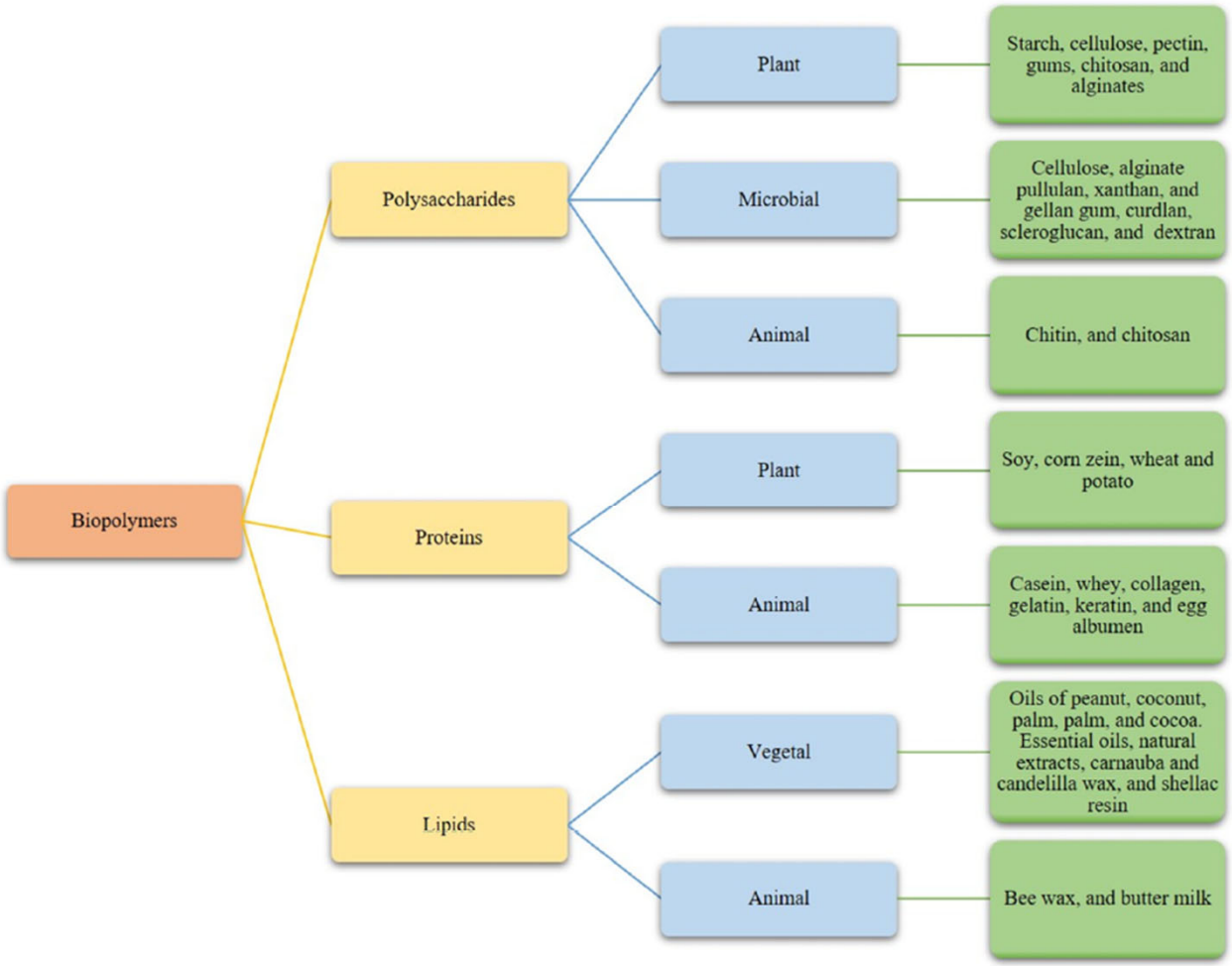
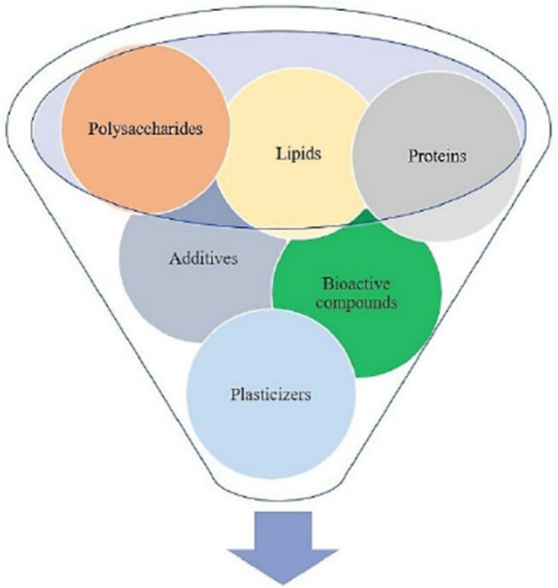


Figure 1. Biopolymers used as natural edible films and coatings and their sources.



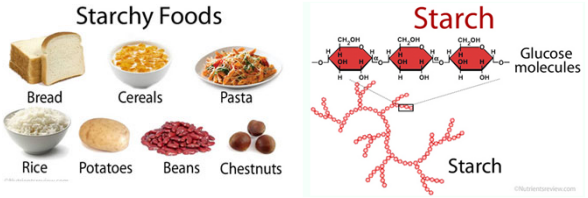
Composite coatings

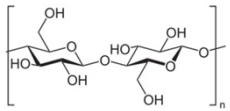
- Improvement of mechanical, water vapor, barrier, thermal, and antimicrobial properties.
- Improve or reduce water solubility.
- Prevention of dissolving and or swelling.
- Provide antioxidant properties.
- Development of more stable structures.
- Moisture content reduction.
- Protection and extension of activity of bioactive compounds.
- Better retention of organoleptic and nutritional properties of fruits and vegetables.

Figure 2. Composite coatings and their properties.

Iniguez-Moreno 2021, An extensive review of natural polymers used as coatings for postharvest shelf-life extension

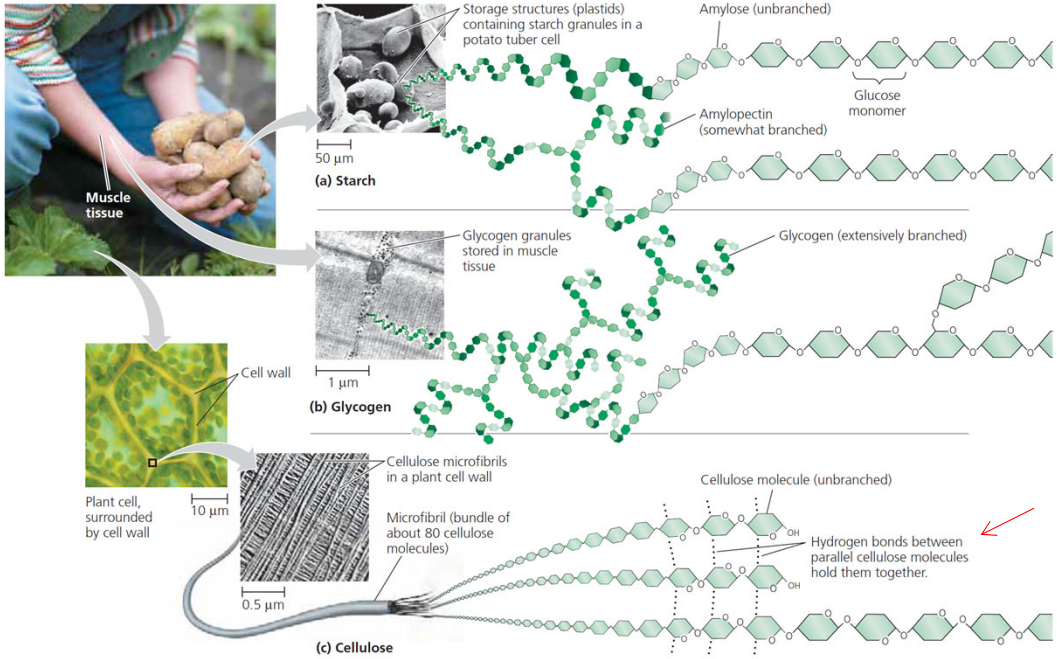
Polymers in Foods: Digestible & Indigestible Fibers



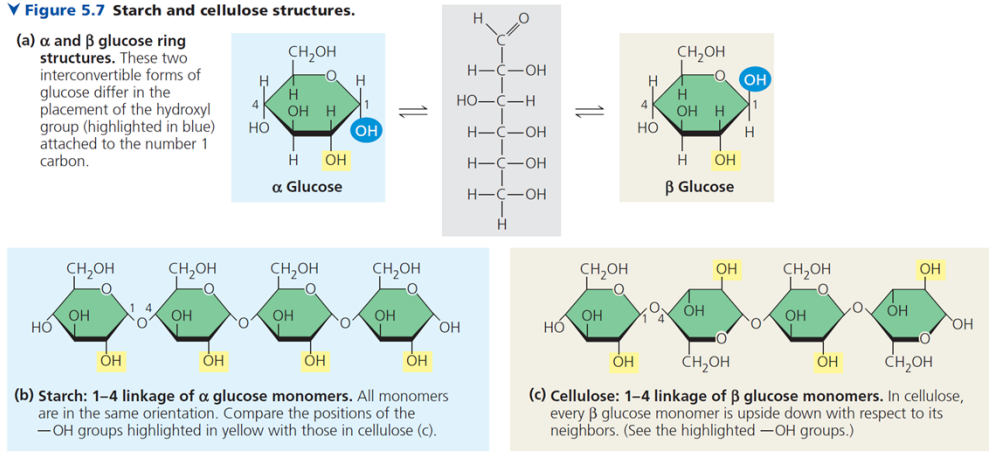


Cellulose

https://www.nutrientsreview.com/carbs/polysaccharides-starch.html



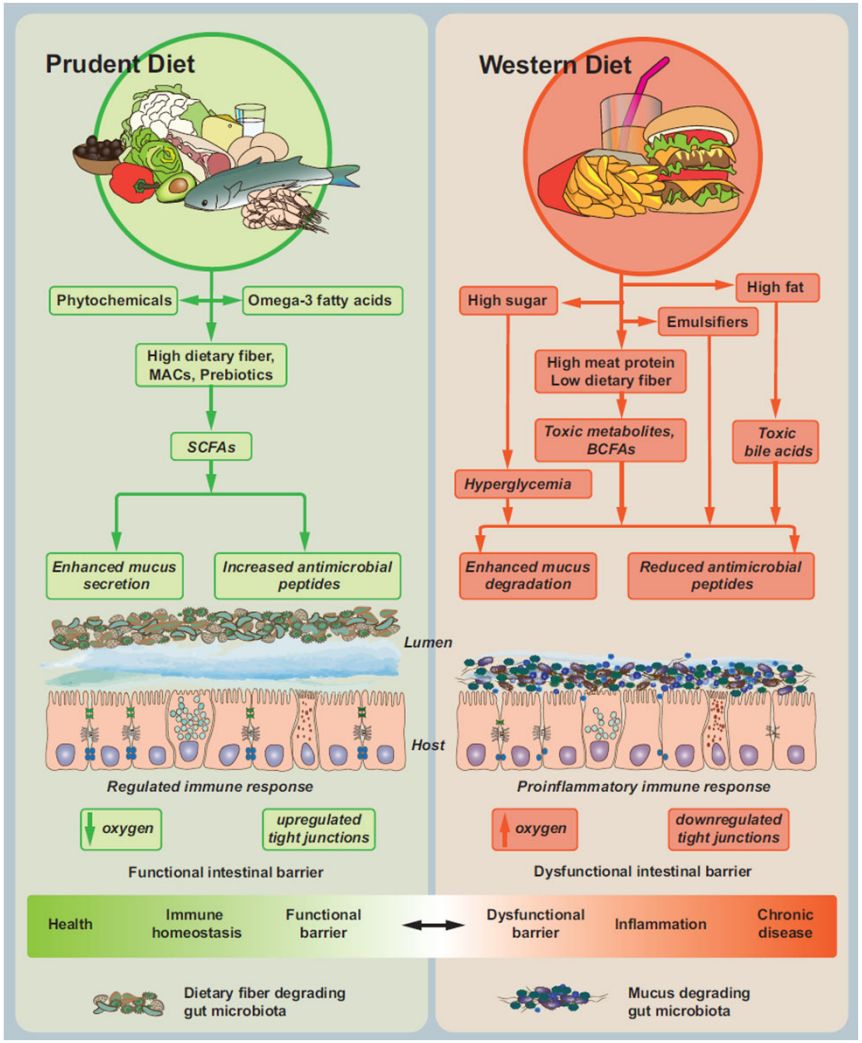
Urry 2021, The structure and function of large biological molecules

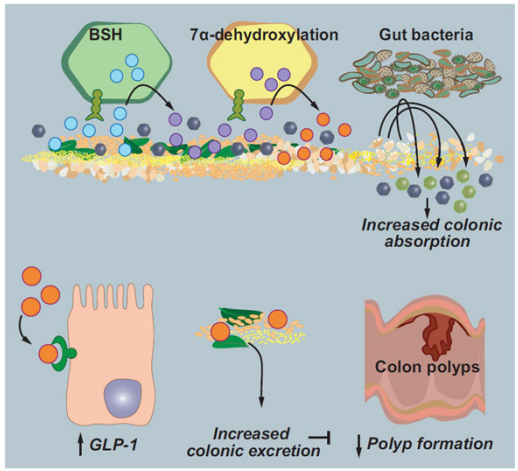


Human: The World Within. Fuel (Netflix) Robynne Chutkan, M.D. Gastroenterologist

Dietary Fiber

Makki 2018, The Impact of Dietary Fiber on Gut Microbiota





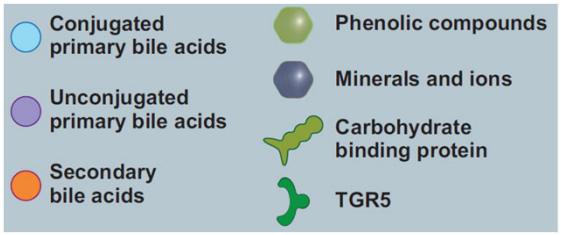


Figure 2. Short-Chain Fatty Acid (SCFA)-Independent Effect of Dietary Fibers in Colon:
Dietary fibers bind conjugated primary bile acids (BAs) and may serve as a platform for gut bacteria that possess the bile salt hydrolase (Bsh), leading to the production of non-conjugated BAs. These can also bind to dietary fibers and be further metabolized by specific bacteria with 7-alpha dehydroxylation activity, thus generating secondary BAs. The fact that dietary fibers can bind secondary BAs suggests that they may play a role in regulating BA levels within the gut. This structural interaction may modulate host physiology either by preventing the accumulation of toxic BAs that can lead to the development of polyps and colorectal cancer (CRC) or by increasing the disposal of BAs that can activate TGR5 to increase glucagon-like peptide 1 (GLP-1) secretion. In addition, bacterial degradation of dietary fibers leads to the release of minerals and phenolic compounds, which can be absorbed by the distal gut.

Figure 1. Effect of Low- and High-Fiber Diet on Gut Microbiota Composition, Diversity, and Function in Host Physiology:
A diet rich in fiber contributes to the maintenance of a healthy gut microbiota associated with increased diversity and functions such as the production of short-chain fatty acids (SCFAs). With the industrialization of the diet, low fiber intake, and high protein and sugar consumption, the diversity of the gut bacteria is reduced and their function is altered, including significant reduction in their ability to produce SCFAs, and associated with the appearance of chronic inflammatory diseases. High fiber intake and the production of SCFAs by the gut bacteria enhance mucus and anti-microbial peptide production, and increase expression of tight junction proteins. In addition, SCFAs reduce oxygen levels and maintain a functional immune system. These biological processes are disrupted when the diet is shifted toward a Western lifestyle and may lead to increased susceptibility to infections and IBD, and to impaired physiology.

Mediterranean Diet

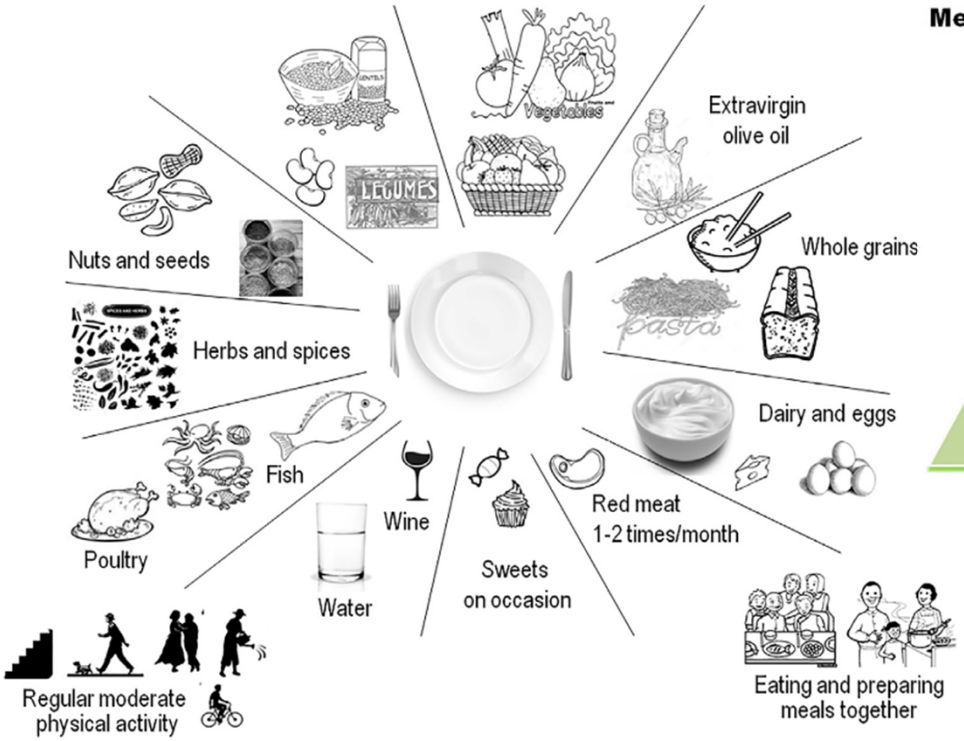
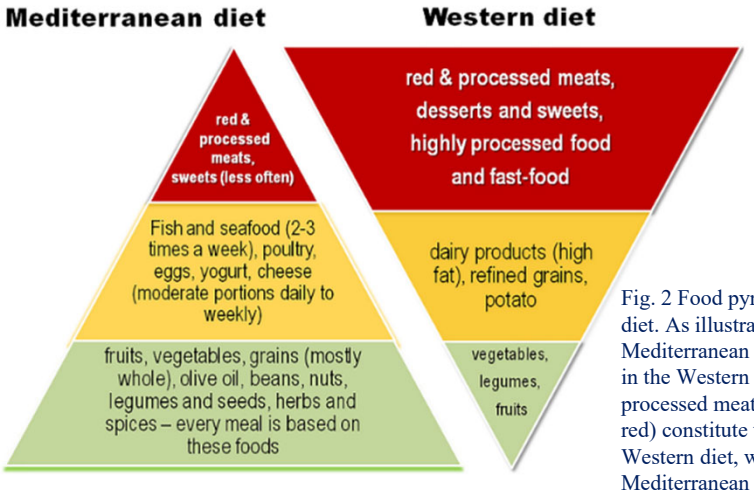


Fig. 3 Nutritional and lifestyle components of the Mediterranean dietary pattern, which has been associated with improved longevity and reduced incident age-related chronic diseases.



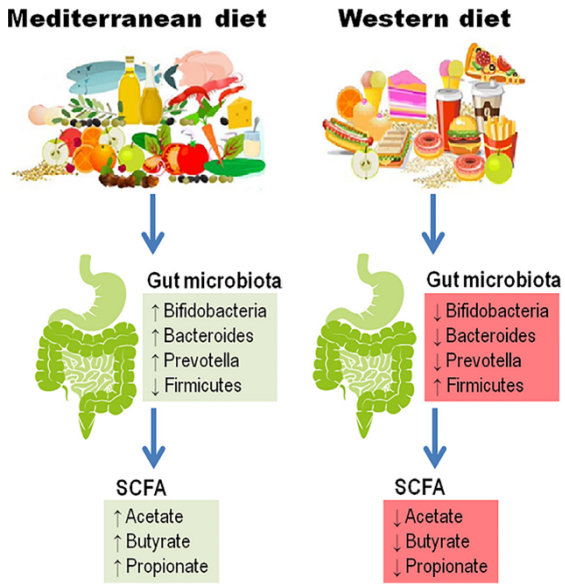


Fig. 2 Food pyramids of Mediterranean and Western diet. As illustrated by the pyramids, the basis of the Mediterranean diet (in green) is minimally represented in the Western diet, while the consumption of red and processed meats, sweets, industrial- and fast-food (in red) constitute the majority of consumption in the Western diet, while is minimally represented in the Mediterranean diet. High-fat dairy products, refined grains, and potato (yellow) are also frequently consumed in the Western diet, as opposed to the Mediterranean diet where other healthy foods are consumed instead.

Fig. 4 The Mediterranean diet and the Western diet produce modifications in the gut microbiota composition with subsequent changes in short chain fatty acid (SCFA) production.

Dominguez 2020, Mediterranean diet and longevity

Foods and Cancer

Increased Cancer Risk May Be Linked to Ultra-Processed Foods

A new study led by researchers from Imperial College London and published in eClinicalMedcine suggests that higher consumption of ultra-processed foods may be linked to increased risks of developing and dying from cancer. Ultra-processed foods include fizzy drinks, mass-produced package breads, many ready meal and the majority of breakfast cereals.

"This study adds to the growing evidence that ultra-processed foods are likely to negatively impact our health including our risk for cancer. Given the high levels of consumption in UK adults and children, this has important implications for future health outcomes," said lead senior author Eszter Vamos of Imperial College London's School of Public Health. "Although our study cannot prove causation, other available evidence shows that reducing ultra-processed foods in our diet could provide important health benefits."

Ultra-processed foods are often inexpensive and heavily marketed—sometimes even as healthy food options—but they are usually higher in salt, fat, sugar and contain a ranges of artificial additives. They are already linked to the development of other diseases such as obesity, type 2 diabetes, and heart disease.

https://www.insideprecisionmedicine.com/topics/oncology/increased-cancer-risk-may-be-linked-to-ultra-processed-foods/?MailingID=%DEPLOYMENTID%c

Chang 2023, Ultra-processed food consumption, cancer risk and cancer motality

The researchers used records of 200,000 middle-aged adults contained in the UK Biobank for their study and monitored their health over the course of a 10 years. They looked for overall cancer risk, as well as the risk of developing 34 specific types of cancer along with cancer mortality rates.

The data from the study showed that for every 10% increase in a person's diet of ultra-processed food, they had a 2% greater risk of developing any kind of cancer, but 19% increased risk of developing ovarian cancer. Each 10% increase was also associated with an increased cancer mortality risk of 6% from all cancers, and 16% and 30% increased risk of mortality from breast cancer and ovarian cancer respectively. The investigators said all the links remained even after adjusting for a range of social determinants of health such as socio-economic, dietary, and behavioral factors such as smoking, exercise, and body mass index.

The team, which included researchers from the International Agency for Research on Cancer (IARC), University of São Paulo, and NOVA University Lisbon, has previously reported findings linking a diet high in ultra-processed foods to greater risks of obesity and type diabetes in adults in the U.K. and greater weight gain in U.K children, which extends into young adulthood.

"The average person in the UK consumes more than half of their daily energy intake from ultra-processed foods," noted first author Kiara Chang of Imperial College London. "This is exceptionally high and concerning as ultra-processed foods are produced with industrially derived ingredients and often use food additives to adjust color, flavor, consistency, texture, or extend shelf life. Our bodies may not react the same way to these ultra-processed ingredients and additives as they do to fresh and nutritious minimally processed foods. This shows our food environment needs urgent reform to protect the population from ultra-processed foods."

Some countries have taken steps to reduced ultra-processed food consumption with Brazil, France, and Canada updating their dietary recommendations in an attempt to lower their consumption. Brazil has taken the additional step of banning the marketing of these foods in schools. Further, The WHO and the United Nations' Food and Agricultural Organization have recommended restricting ultra-processed foods in the diet.

"Lower income households are particularly vulnerable to these **cheap and unhealthy ultra-processed foods**," Chang said, further suggesting that fresh meals with minimal processing could be subsidized as a part of public policy to ensure all people have access to healthier food options.

Water Bottles

https://bottledwater.org/packaging/

Bottled water packaging has the lowest environmental footprint of all packaged drinks.

All bottled water packaged in plastic containers are 100 percent recyclable, including the cap (but only when it is attached to the bottle).

Most bottled water companies package their products using plastic or glass containers. Plastic containers comprise 97.3 percent of the bottled water market, while glass bottles account for 2.

Plastic bottled water containers are made from polyethylene terephthalate (PET), polycarbonate (PC), and high density polyethylene (HDPE) plastics. PET accounts for 78.8 percent of plast 12 percent, and HDPE for 9.2 percent.

Polyethylene terephthalate (PET) plastic, easily identified by the #1 recycling code on or near the bottom of the container, is probably the bottled water packaging material most people re 100 percent recyclable and used to make convenient, portable 24 ounce, 16.9 ounce (half-liter), and kid-friendly 8 ounce bottled water containers. Some bottled water companies even use PI and 5-gallon jugs typically used with water coolers. But bottled water containers aren't the only food product packaged in PET plastic. A variety of foods – everything from peanut butters, s sauces, baked goods, soft drinks, fruit juices, beer, wine, and spirits – are available in PET plastic containers. The bottled water industry has made significant inroads in reducing the amount bottled water containers. Between 2000 and 2014, the average weight of a 16.9-ounce, single-serve PET plastic bottled water container declined 51 percent to just 9.25 grams. Some weigh a This is only a fraction of the amount of PET it takes to make soda and other drink containers—which must be thicker due to carbonation and manufacturing processes and weigh, on average addition, many bottled water companies already use bottles made from 50, 75, and even 100 percent recycled PET (rPET). In 2015, the Beverage Marketing Corporation (BMC) reported tha 2014, the use of rPET in bottled water packaging increased by 17.5 percent to 21 percent. For bottled water companies that use rPET, the average rPET content in 2014 was 20 percent per c

High density polyethylene (HDPE) is another plastic bottled water packaging material that FDA has approved as safe for food contact. HDPE, which is 100 percent recyclable and easily ic recycling code on or near the bottom of the container, is used to package not only bottled water but also other food items such as milk and juice, and also other products easily found around shampoo, dish soap, and laundry detergent bottles. HDPE is typically used as bottled water packaging in 1-gallon jugs and 2-gallon water dispensers available at grocery stores. HDPE is fre recycled. Recycled HDPE can then be used to make new bottles and jugs.

Polycarbonate plastic has been a packaging material used for food and beverage product containers for more than 50 years because it is lightweight, highly shatter-resistant, and transparent companies have used polycarbonate plastic for their 3- and 5-gallon water cooler bottles. Returnable polycarbonate 3-and 5-gallon HOD bottled water containers are cleaned and sanitized between uses and are reused 30 to 50 times before being recycled. In addition to food containers, polycarbonate has been widely used in many other everyday items, such as eyeglasses and compact discs. As with all food packaging materials, bottled water containers made from polycarbonate are approved by FDA for food contact. Polycarbonate plastic and epoxy resins are made using bisphenol A (BPA), which is a chemical building block that FDA and other regulatory agencies around the world have deemed as safe for consumer use. In fact, FDA has stated that according to the agency's "ongoing safety review of scientific evidence, the available information continues to support the safety of BPA for the currently approved uses in food containers and packaging." To learn more, visit IBWA's "What Is BPA?" webpage or FDA's BPA webpage.

Glass is a packaging option some bottled water companies choose to use for their premium bottled waters. Glass packaging combines raw materials, including sand, soda ash, limestone and cullet, creates glass containers that are durable, strong, impermeable, easily shaped, and inexpensive. Today's glass containers also require less material to make, weight almost 40 percent less than they did 30 years ago. Efforts to continue to reduce the weight of glass containers are ongoing throughout the industry. Glass containers for food and beverages are 100 percent recyclable. Recycled glass is always part of the recipe for glass, and the more that is used, the less energy is needed to make it. Glass is recyclable, but it is up to consumers to ensure that their local recycling facility accepts glass.

IBWA and its members approach packaging issues in a manner that emphasizes the most effective and efficient solutions to reduce the impact on the environment, while also taking into account the equal responsibility of other industries and companies that use plastic containers.

How is plastic packaging recycled?

All bottled water packaging is 100 percent recyclable with well-established services in place to support the recycling of these containers—from widespread collection and separation to processing and end use.

Virtually all recycling programs in the United States accept PET, PC and HDPE plastic containers. Many types of plastic, such as PET and HDPE, can be recycled multiple times.

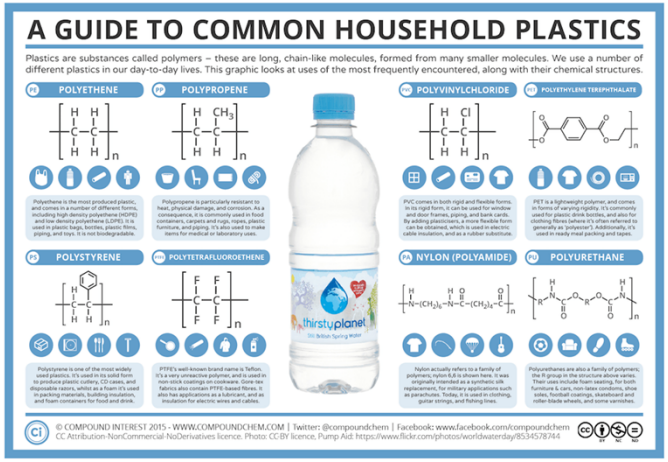
Plastics reclaimers wash, grind and further process plastic resin for reuse in new products. Recycled PET is often used to make new bottles, but can also be made into fiber for carpets; fabric for t-shirts or fleece jackets; fiberfill for sleeping bags, winter coats, and dog beds; industrial strapping; sheet and thermoformed (clamshell) packaging; and automotive parts, such as headliners, bumpers, and door panels. Nearly 1.8 billion pounds of PET were recycled in 2013, and more than 1.5 billion pounds of recycled PET material were used in U.S. and Canadian end products. For every pound of recycled PET flake used, energy use is reduced by 84 percent, and greenhouse gas emission by 71 percent.

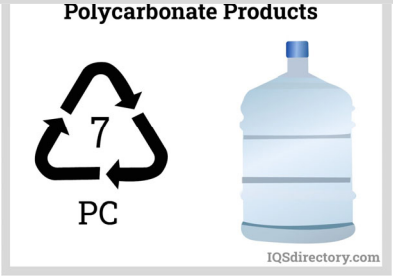
The current U.S. recycle rate for PET bottled water containers is 33.4 percent—3.3 percent higher than the rate for all PET bottles (30.1 percent). In addition, bottled water is the number one product collected in curbside programs, by container count. These containers make up 51 percent of what is collected in curbside and 68.47 percent of Expanded Deposit recycling programs in New York and Connecticut. The recycling rate for all HDPE bottles including water was 34.4 percent in 2015.

Glass containers are also 100 percent recyclable and do not degrade through the recycling process, so they can be recycled again and again. In 2014, roughly 32.5 percent of all glass containers were recycled. When glass containers are recycled, they enter facilities where they are sorted by color and washed to remove any impurities. The glass is then crushed, melted, and molded into new products such as bottles and jars. Glass can also be used for other purposes, such as brick manufacture or decorative uses.

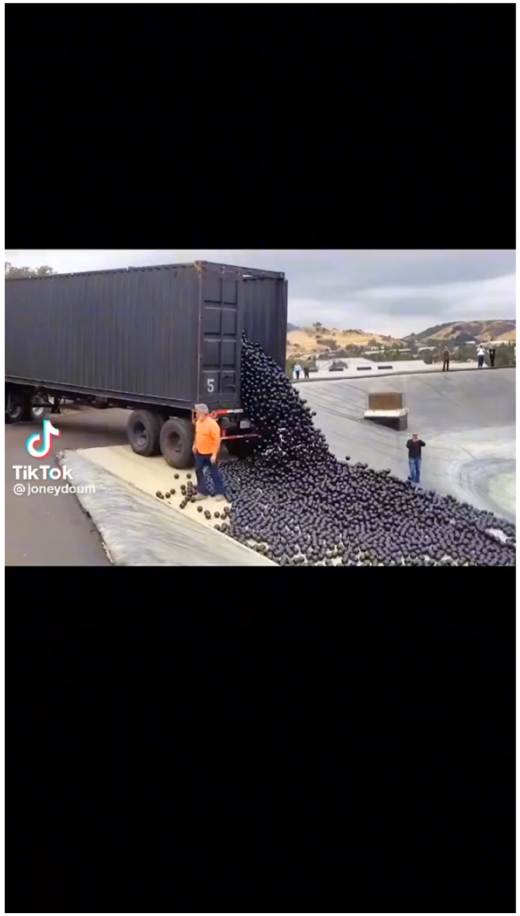
The bottled water industry has made great efforts and accomplished great strides in producing packaging that uses less material and energy and is 100 percent recyclable. Although the recycling rate for bottled water containers is higher compared to other packaged beverages, the industry is equally committed to improving current recycling rates.

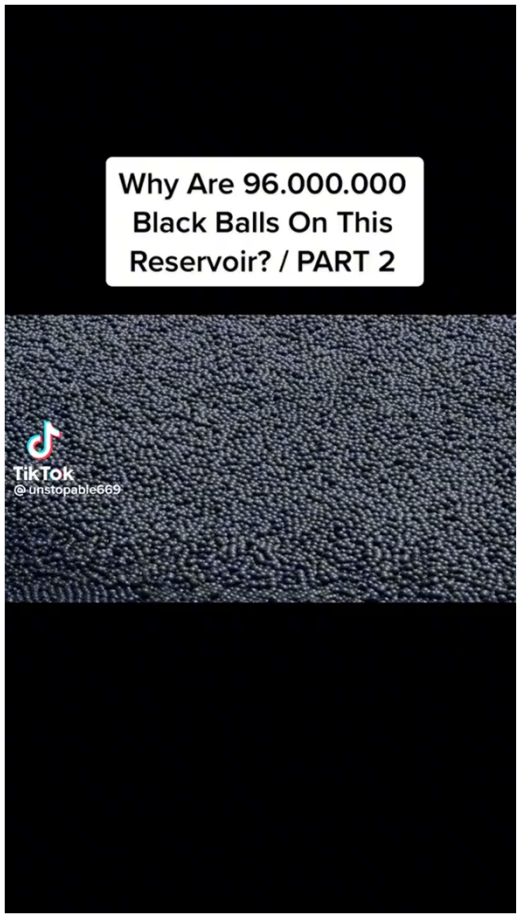
Because these rates are in the hands of consumers, bottled water companies are focusing their efforts on behavioral solutions, such as public education and enforcement of existing recycling and litter control laws.

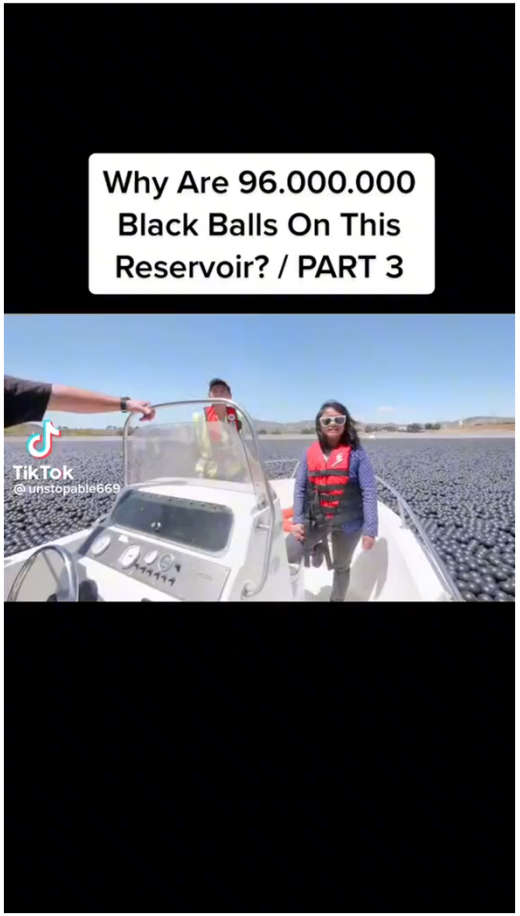


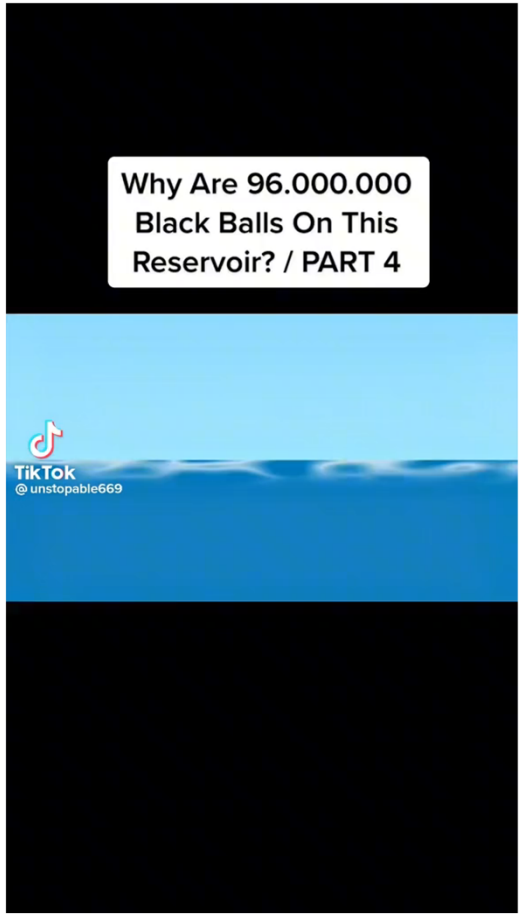


Prevention of Bromate in Water Reservoir: HDPE









Polymers in Glasses

Eye Glasses

Cellulose acetate is the caviar of plastics. It's durable, hypoallergenic, and capable of holding exceptionally rich colors, which makes it an ideal material for eyeglasses. It's our signature material.

Polycarbonate is an über tough transparent plastic with exceptional impact resistance. (It won't break if you drop it, unlike eggs, crystal vases, fine china, water balloons, etc.). Optical lenses are fashioned from polycarbonate.

Nose pads
win pads that rest on the sides of your nose and ensure a snug fit.
Silicone rubber, poly(vinyl chloride), and polycarbonate

While glass is naturally scratch resistant, most plastics are not. To compensate, manufacturers have developed a variety of ways to apply optically clear hard films to the lens. Films are made of materials such as diamond-like carbon (DLC) and polycrystalline diamond. Through a process of ionization, a thin but extremely durable film is created on the surface of the lens. See Patent 5,268,217 for details.
https://science.howstuffworks.com/innovation/everyday-innovations/sunglass8.htm

Polysiloxane-based thermal cure coating that combines water sheeting anti-fog performance with abrasion resistance. Dip, spin and flow coat compatible, ideally suited for Polycarbonate safety eyewear, shields and visors as well as other applications where optical clarity and high durability are required.

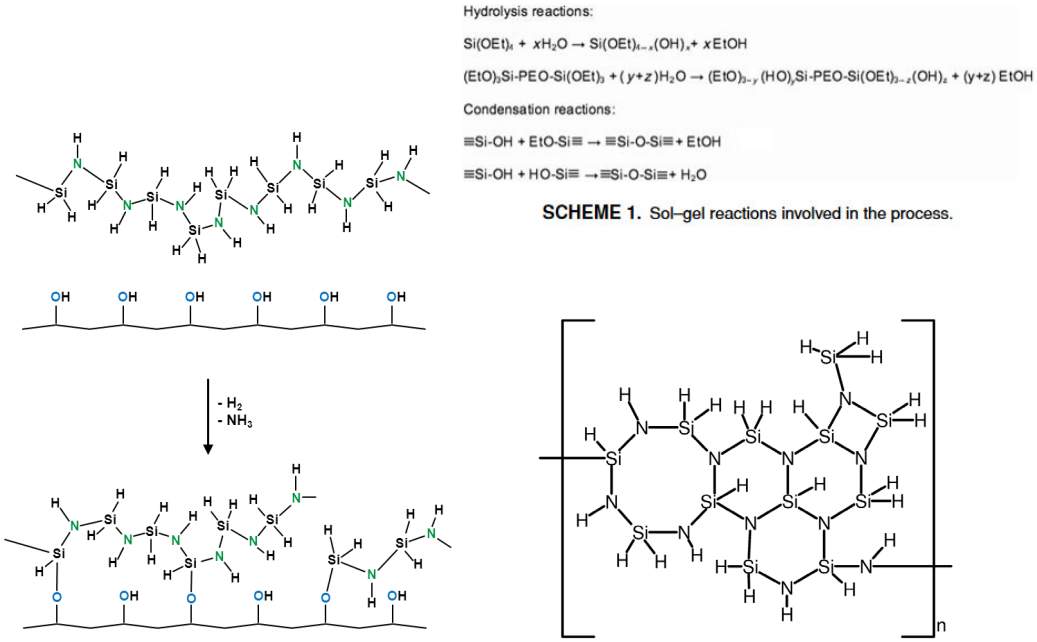
Abrasion/Scratch Resistant, Thermal, Polysiloxane, Dip, Primerless, Military Eyewear, Anti-Fog, Automotive, Flow, Safety (PPE), Headlamps & Gauges, Compatible with Anti-Reflective Coatings, Mirror, Metalizing Treatments, Spin, Sports & Sunglass, Transit, Polycarbonate, REACH Compliant

https://clearchoice-coatings.com/?gclid=EAIaIQobChMIqdbGwqfr5gIVYpJbCh1XNQOMEAMYAiAAEgJ6QfD_BwE

Scratch-Resistant Coating

Lens coatings: Anti-reflective, scratch resistant, anti-fog, UV

α,ω-Triethoxysilane-terminated PEO (PEOSi) was prepared by the bulk reaction of PEO with 3-isocyanatopropyltriethoxysilane (molar ratio of 1:2). The molecular structure of the final product can be represented as follows: $(EtO)_3Si\text{-}PEO\text{-}Si(OEt)_3$.
Fabbri 2008, Enhancing the scratch resistance of polycarbonate with PEO-silica hybrid coatings



SCHEME 1. Sol–gel reactions involved in the process.

Polysilazanes are polymers in which silicon and nitrogen atoms alternate to form the basic backbone.

Durazane® 2000 series: Inorganic polysilazanes add a film to surfaces consisting of a quartz, glass-like silicone dioxide. They can be used to add anti-scratch properties and excellent chemical and thermal resistance to a wide range of substrates.

https://www.emdgroup.com/en/brands/pm/durazane.html
https://en.wikipedia.org/wiki/Polysilazane

Smart Glass, Switchable Glass, Electric Glass

Electric glass technologies have undergone changes over the years. Furthermore, they began to consume less energy and their cost is decreasing every year, which makes it possible to bring the product to the masses in the future. It comes by triplexing 2 or more sheets of glass. The laminating films used for its production divides into three types by technology:
EVA - ethylene vinyl acetate film. Its main advantage is the low cost of both the EVA film itself and the equipment for its production. It has good adhesion to plastic and glass, but has a high degree of turbidity and low strength.
PVB - a polyvinyl butyral film. A distinctive feature is that it has a high quality at the output, but at the start – a high production cost. PVB film adheres well to glass, but poorly to plastic. And just like EVA film, (PVB) does not withstand high humidity conditions.
TPU – Thermoplastic polyurethane film. It is most suitable for the production of smart glass. Moreover, TPU film is immune to moisture, aggressive conditions, plus it has high adhesion to both glass and plastic.

Smart glass based on liquid crystal polymer particles (PDLC or LCD)
PDLC and LCD glass comes on the basis of a liquid mixture of polymer crystals located among two layers of glass with an electrically conductive coating and forming a layer of variable transparency. Liquid crystal particles disintegrate into their constituents, and then turn into a solid state. Thus, liquid particles and solid polymer are incompatible, thereby forming inclusions in the polymer. Without electricity, they are chaotically located, light scatters, passing through them, and such glass acquires a matte shade. It can be milky white, milky gray or milky blue. When the electricity turns on, the LCD particles change their position, all as one stand vertically in relation to the glass. And it becomes transparent or translucent, depending on the possibility of the supplied electricity, and the enlightenment can be easy to segment.

The SPD method uses “suspended particles” that come between two layers of electrically conductive coating. SPD film is almost similar in structure to LCD. But thanks to the layered rod-like particle structure, SPD glass smart panels are visually open in different states. When the voltage is off, it is black or dark blue, when the power is applied, the particles align together, and the light can pass unhindered, and it becomes transparent. The switching speed at which it changes color from dark to light blue or gray is almost instantaneous (2-3 sec.).
What is a smart glass and how does it work?
Electric glass mechanism is quite simple, although the technology involved is very advanced. The smart glass comprises two sheets of glass separated by a film of liquid crystal polymer responsive to electricity.
When turned off, the smart glass presents itself as a translucent white partition on which high definition images can be easy to project. When turned on, the electric current organizes the polymers and the structure becomes totally transparent. How to apply this new material in construction projects?

The electric glass can be applicable in various types of residential and corporate design. See below:
To obtain smart glass with variable transparency, manufacturers use triplexing technology:

The basis of the product is triplex – a three-layer structure made of sheets of ordinary glass or polycarbonate, between which a polymer LCD film installs;
outside, on both sides, the sheets are covered with a protective film, which prevents the material from scattering into fragments upon impact;
Another important element of smart glass is a conductive layer that creates an electric field that acts on the crystals.

https://www.wglass.net/what-is-electric-glass/

Polymers in Military & Police

Polymers for Radar-Absorbing Materials (RAMs)

Radar-absorbing material (RAM) is a specialist class of polymer-based material applied to the surface of stealth military aircraft, such as the F-22 Raptor and F-35 Lightning II , to reduce the radar cross-section and thereby make them harder to detect by radar. These materials are also applied in stealth versions of tactical unmanned aerial systems, such as the Boeing X-45. RAM is applied over the entire external skin or (more often) to regions of high radar reflection such as surface edges.

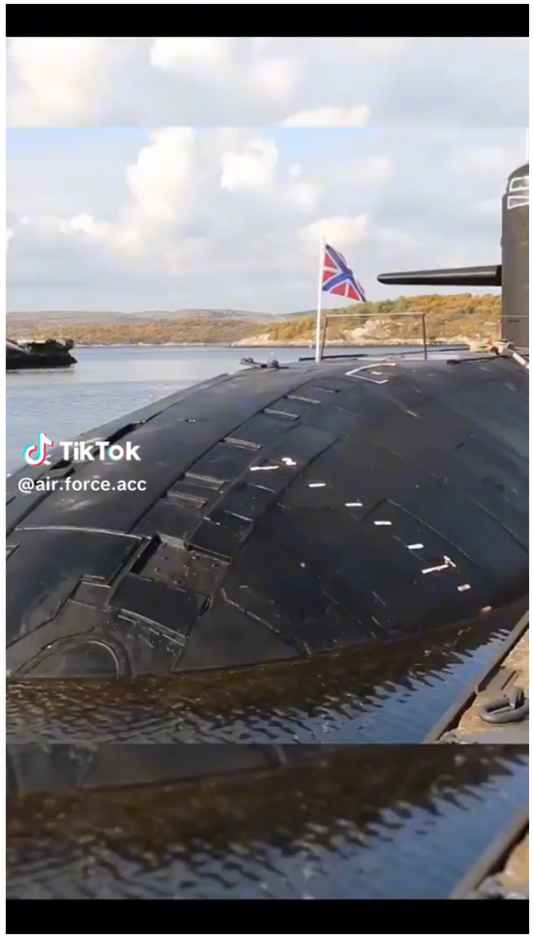
RAM works on the principle of the aircraft absorbing the electromagnetic wave energy to minimise the intensity of the reflected signal. RAMs are used in combination with other stealth technologies, such as planar design and hidden engines to make military aircraft difficult to detect. It is possible to reduce the radar cross-section of a fighter aircraft to the size of a mid-sized bird through the optimum design and application of stealth technologies. Information about the composition of RAMs is guarded by the military.

Most RAMs consist of ferromagnetic particles embedded in a polymer matrix having a high dielectric constant. One of the most common RAMs is called iron ball paint, which contains tiny metal-coated spheres suspended in an epoxy-based paint. The spheres are coated with ferrite or carbonyl iron. When electromagnetic radiation enters iron ball paint it is absorbed by the ferrite or carbonyl iron molecules which causes them to oscillate. The molecular oscillations then decay with the release of heat, and this is an effective mechanism of damping electromagnetic waves. The small amount of heat generated by the oscillations is conducted into the airframe where it dissipates.

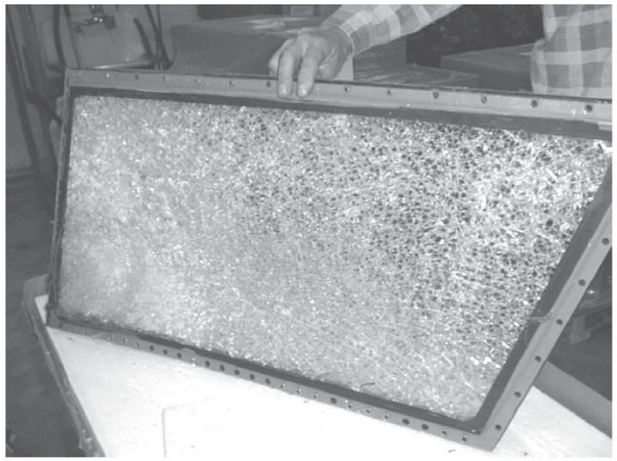
Another type of RAM consists of neoprene sheet containing ferrite or carbon black particles. This material, which was used on early versions of the F-117A Nighthawk, works on the same principle as iron ball paint by converting the radar waves to heat. The USAF has introduced radar-absorbent paints made from ferrofluidic and nonmagnetic materials to some of their stealth aircraft. Ferrofluids are colloidal mixtures composed of nano-sized ferromagnetic particles (under 10 nm) suspended in a carrier medium. Ferrofluids are superparamagnetic, which means they are strongly polarised by electromagnetic radiation. When the fluid is subjected to a sufficiently strong electromagnetic field the polarisation causes corrugations to form on the surface. The electromagnetic energy used to form these corrugations weakens or eliminates the energy of the reflected radar signal. RAM cannot absorb radar at all frequencies. The composition and morphology of the material is carefully tailored to absorb radar waves over a specific frequency band.

Mouritz 2012, A.P. Mouritz. Introduction to aerospace materials
Vora 2022, Research and development of high-performance polymeric materials

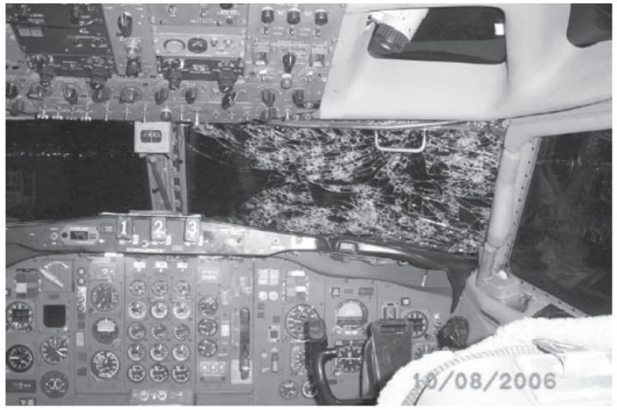
From 1988 to 1991, Hoechst Celanese Corp., NJ, USA was a leading collaborator in a US DARPA Program for the development of high-temperature, high-performance composite matrix resins based on SIXEF-Polyimide [PI]/ Polybenzimidazole [PBI] blends for “low observable” supersonic Advanced Tactical Fighter (ATF) plane (AT-71, a.k.a F-117)’s structural components, under funding from NASA (Lewis) and DARPA. This team involved scientists from major aircraft companies, (Boeing and Lockheed), as well as major military aircraft engine manufacturer, (General Electric Engine Division), major resin producer (Hoechst Celanese Corp SIXEF Polymers Group) and leading universities (University of Massachusetts, MIT, Virginia Polytechnic, University of Akron, and South West Texas State University).



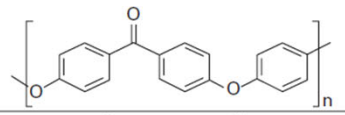
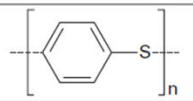
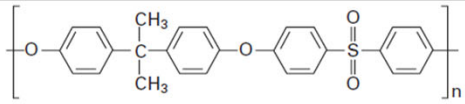
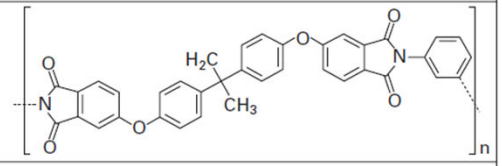
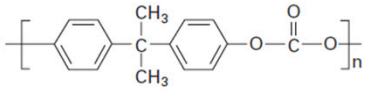
Shatter-proof Windows



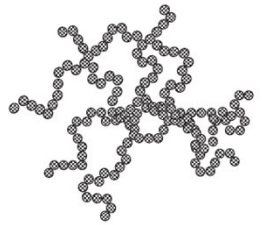
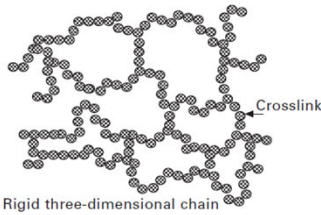
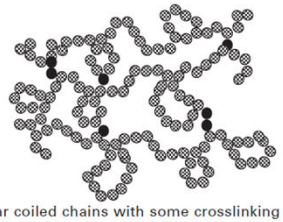
13.9 Bird strike damage to a cockpit window. Photograph reproduced with permission from AirSafe.com.



13.10 Hail damage to a cockpit window.

Polyether ether ketone (PEEK)	
Polyphenylene sulfide (PPS)	
Polysulfone (PSU)	
Polyetherimide (PEI)	
Polycarbonate	

13.8 Thermoplastics used in aircraft.

Thermoplastic • moderate stiffness • moderate strength • high ductility • high impact resistance • poor creep resistance • recyclable	 Flexible linear chains with no crosslinking
Thermoset polymer • high stiffness • high strength • high creep resistance • low/moderate ductility • poor impact resistance • cannot be recycled	 Crosslink Rigid three-dimensional chain structure with crosslinking
Elastomer • very low stiffness • low strength • very high elasticity • excellent impact resistance • not easily recycled	 Linear coiled chains with some crosslinking

13.1 Basic properties of thermoplastics, thermoset polymers and elastomers.

Mouritz 2012, A.P. Mouritz. Introduction to aerospace materials

Polymers for Soldiers

Motors, mounted at the waist and attached by cables to joints, transmit force at key moments in the walking cycle, augmenting muscle strength.

The Warrior Web suit conforms to the lower body and supports the hip, knee, and ankle joints.

The suit is made of nylon in places where force is applied, and spandex where it needs to be flexible. A new type of soft sensor monitors motion so that the suit works smoothly.

POWERED EXOSUITS

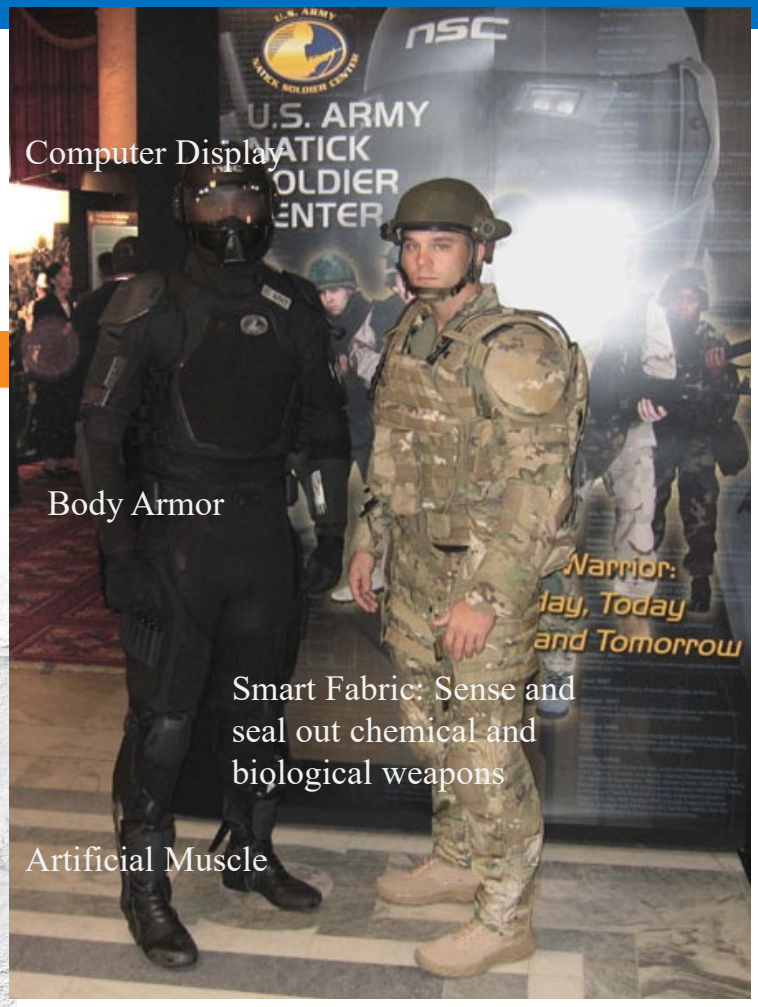
SOME WEIGHT troops will never shed. That's why DARPA is creating the Warrior Web, a soft, flexible suit that supports the back and lower body. It uses a system of springs to store the energy a soldier produces while walking or running. Motors then release and augment this power in times of need. The suit could reduce metabolic energy use by 25 percent, says Lt. Colonel Joseph Hitt, former program manager at DARPA. Warrior Web also reduces stresses on the ankle, knee, and hip joints, helping to prevent injury. Though it adds 20 pounds, the suit compensates for its weight with just 100 watts of battery power (roughly twice that of a laptop). Early prototypes fit comfortably beneath a soldier's regular uniform, and DARPA says a final version is on track for 2016.

Another suit in development aims to more dramatically boost soldiers' power. "The next generation of technologies is not just about lightening the load, but also about enhancing human performance," says Peter W. Singer, a defense expert at the New America Foundation and author of *Wired for War: The Robotics Revolution and Conflict in the 21st Century*. Developed by U.S. Special Operations Command (SOCOM), the Tactical Assault Light Operator Suit (TALOS) resembles Iron Man's mechanical outerwear. It even shares the same pedigree. Legacy Effects, the Hollywood special effects shop that designed the movie's exoskeleton, had a hand in designing it. The robotic full-body armor could

PORTABLE SOLAR

THE TOOLS OF modern warfare draw a lot of power. Even on short missions, the batteries for night-vision goggles, radios, laptops, and GPS devices add between 15 and 20 pounds to a soldier's load. The Marine Austere Patrolling System (MAPS), developed under the oversight of the Office of Naval Research (ONR), could replace that burden with a 6-pound system that could be deployed within the next five years. A flexible solar panel can be attached to convert sunlight to electricity with 30 percent efficiency—a 27 percent improvement over the stationary panels now in use by the military. MAPS can also transfer electricity from a fully charged device to a dead one and future versions may contain a membrane water-filtration system that enables Marines to produce clean water from nearly any source.

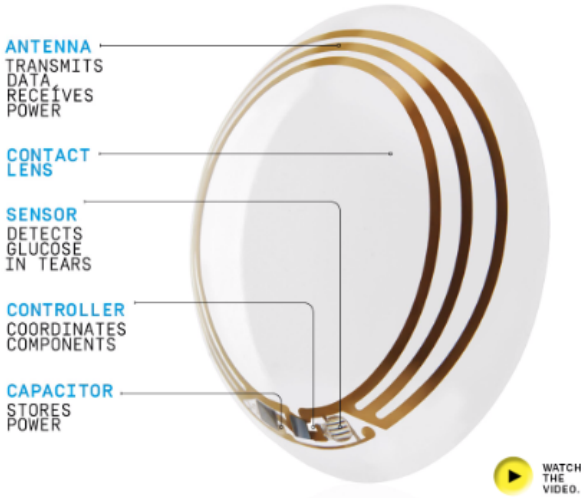
Perhaps just as important, field tests in 2013 revealed that MAPS gives Marines the confidence to resist dragging extraneous equipment on patrol. With their lives on the line, soldiers often over-pack, says Marine Capt. Frank Furman, an ONR program manager for logistics. So new technologies can't just replace old ones, he says. "It's also about replacing the psychological security blanket."



http://www.gizmag.com/go/3062/

Smart Contact Lens: How Smart is Smart Enough to be Useful?

TECH WATCH / **BIOTECHNOLOGY**



Sight for Smart Eyes

GOOGLE IS WORKING ON A WEARABLE DEVICE DESIGNED TO TACKLE AN ESCALATING CHRONIC DISEASE.

BACK IN 2008 AND AGAIN IN 2012, POPULAR MECHANICS REPORTED ON research from University of Washington professor Babak Parviz, who first proposed a contact lens that could integrate an electronic circuit, then built an actual lens that contained a single pixel of overlay information and was tested in rabbits. Now Parviz is a project leader at Google, which has announced prototype soft contact lenses that incorporate electronics that can measure the glucose level in tears once per second, replacing the finger pricks that diabetics use to monitor their blood-sugar levels. Google is in discussions with the FDA about researching and developing the lenses for consumers.

— *ALEX HUTCHINSON*

Neil Armstrong’s Spacesuit

How the Smithsonian Will Save Neil Armstrong's Spacesuit

The garment Neil Armstrong wore when he became the first man to walk on the moon is deteriorating. Here's what the Smithsonian will do with the more than $700,000 the public has pledged to fix it.

Rubber Protection

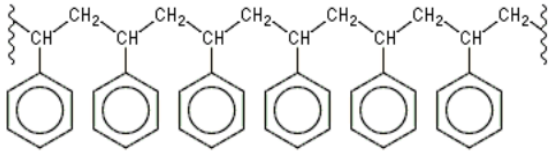
When NASA built the suit, it was concerned with only one thing: getting the astronauts to the moon and back. The suit designers didn't care about museum exhibits, so they chose to use a mix of natural and synthetic rubbers with a six-month life span. In fact, they couldn't order the suits too early or they would degrade before the mission was complete. Today **the rubber has become brittle. Oxidation, UV radiation, and temperature are all factors in the deterioration**, so a new display case with a ventilation system will stabilize the rubber at 65 degrees Fahrenheit, 30 to 34 percent relative humidity, and about 100 lux.

Stripping of Surface Coatings

Sometimes past preservation is the enemy of current conservation: Protective coatings, such as those applied to Armstrong's suit before it was allowed on a post- mission tour, often break down before the object itself. Research will determine exactly what coatings have been applied—conservators suspect Teflon—and whether mechanical or chemical means should be used to remove them.

http://www.popularmechanics.com/space/moon-mars/a17583/neil-armstrong-spacesuit/

Polystyrene Cables



1937

A polystyrene yogurt container

LANDINGS

VERSION 1.0 When a 50,000-pound fighter lands on the *Reagan* at 150 mph, a hook bolted to the jet's tail catches one of three polystyrene arresting cables on the deck, yanking the aircraft to a halt in 350 feet. The brute force of those arresting wires wears down fighters and could break lightweight drones.

UPGRADE Engineers are developing a system that will ID incoming aircraft and automatically adjust cable tension for a smoother landing.

http://www.wired.com/wired/archive/11.09/navy_pr.html

Arresting cables are usually made of steel.

Drones: Unmanned Aerial Vehicles (UAVs)

Composite Materials http://www.azom.com/article.aspx?ArticleID=12234

A composites are materials made of two (a matrix or binder and a reinforcer) or more constituents with different physical or chemical properties. When these materials are combined, the new material has different characteristics from the individual components.

Usually the load is carried out by the fiber (from 70-90% of the load) and the rigidity and shape is provided by the matrix, which transfers the load to the fibers and stops or slows the propagation of cracks by isolating the fibers so that individual elements can act separately.

However, one of the most import characteristics to take into consideration when working with composites is that their mechanical properties, such as strength, usually depend upon the direction of the applied load. These materials have been used for thousands of years in the form of concrete and mud bricks, as well as wood and bones being natural composites.

The History of Composites in the Aerospace Industry

Composite materials are not a stranger to the aerospace industry and as early as the 1940s, glass fiber reinforced polymers (GFRP) began to find their way into the maritime industry. In 1944 the first aircraft with composites in its fuselage was flown in the US, an experimentally modified Vultee BT-15.

In the early 1960, composites were used in the form of 'pre-pegs', which consist of a series of fibre-reinforced plastics (FRP) pre-impregnated with an epoxy resin. Examples can be seen in the wings and forward fuselage of the AV-8B Harrier and the tail of the A-320, as well as other military aircraft such as the Eurofighter 2000.

Recently, Airbus increased its use of composites from 25% in the iconic A380 to 53% in the new A350 XWB. Boeing did the same: 12% of the structure of the 777 is made of composites and now their newest aircraft, the 787, is comprised in a 50% of composites. This produced a reduction in weight of 20% in the 787 and reduced scheduled and non-routine maintenance due to a reduced risk of corrosion and fatigue.

Designing UAVs Using Composite Materials

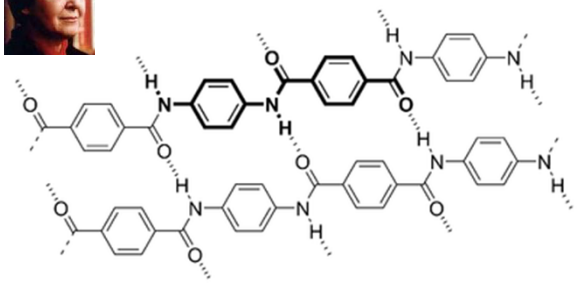
This use of composites is reflected in the UAV industry. In 2009, a survey of 200 models by composite world found that all of the models have composites components and a number of cases reported the use of carbon fiber for the construction of airframes.

However, the increased demand for payload capacity and drone performance made the industry switch to another composite for the construction of the drone structure: carbon fiber-reinforced polymers (CFRP) which is now the primary material used in the construction of the UAV airframes.

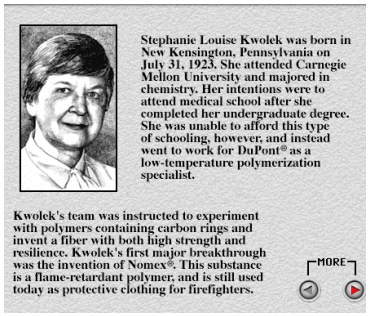
In general, CFRP composites use thermosetting resin, which cures when heated, in combination with carbon fiber as the primary structural component. This makes the material lighter than GFRP composites as well as stronger, even when compared to metals.

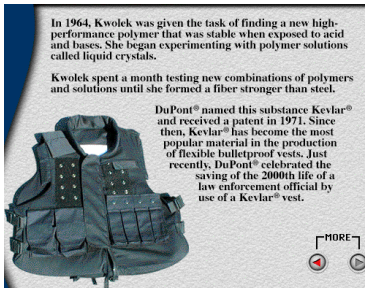
Polyaramide: Poly(*p*-phenylene terephthalamide) (Kevlar)

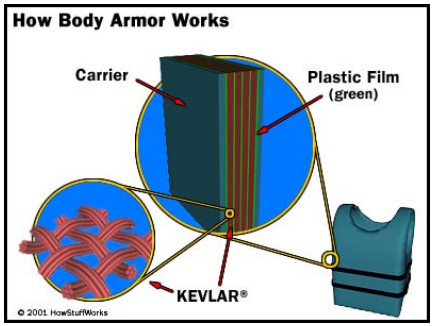
1964 Stephanie Kwolek

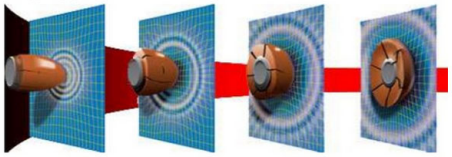


https://www.sciencehistory.org/historical-profile/stephanie-l-kwolek

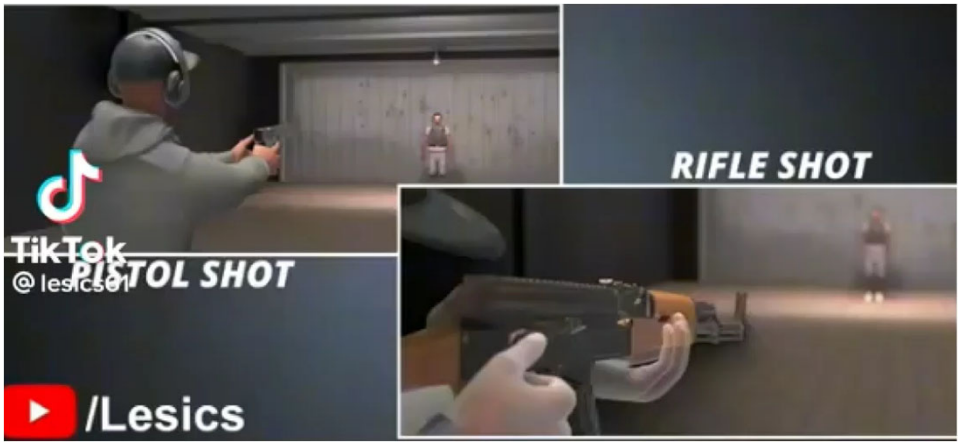








https://www.bodyarmour.shop/blogs/body-armor-wiki/how-does-armor-work



Polyaramides, such as Kevlar, are known for their incredible strength and durability. Polyaramides are a type of polyamide which contain an aromatic ring.
Properties: Fire resistant, durable, strong, virtually impenetrable.
Used in bulletproof vests, underwater cables, reinforcement fibers for automobile tires, canoes, jackets, rain coats, aviation.

How It Works?
When a handgun bullet strikes body armor, it is caught in a "web" of very strong fibers. These fibers absorb and disperse the impact energy that is transmitted to the bullet proof vest from the bullet, causing the bullet to deform of "mushroom." Additional energy is absorbed by each successive layer of material in bullet proof vests, until such time as the bullet has been stopped.

Reconstructing Ancient Linen Body Armor Unraveling the Linothorax Mystery (Gregory S. Aldrete, Scott Bartell, and Alicia Aldrete)

Laminated Linen Protected Alexander the Great

This mosaic of Alexander the Great shows the king wearing linothorax - an armor made from laminated linen.

Reconstructing Ancient Linen Body Armor Unraveling the Linothorax Mystery (Gregory S. Aldrete, Scott Bartell, and Alicia Aldrete)

Alexander and his soldiers protected themselves with linothorax, a type of body armor made by laminating together layers of linen. The main visual evidence for Alexander wearing linothorax is the famous "Alexander Mosaic" from Pompeii, in which the Macedonian king is depicted with this sort of armor.
Indeed, in his "Life of Alexander," the Greek historian Plutarch states that Alexander wore "a breastplate of folded (or doubled) linen" at the Battle of Gaugamela in 331 B.C. This battle a was a huge victory for the Greeks and led to the fall of the Achaemenid Empire. According to the researchers, there is further evidence that linen breastplates were standard equipment in the Macedonian army.

"The hardest part of the project was finding truly authentic linen. It had to be made from flax plants that were grown, harvested and processed, spun and woven by hand," Aldrete said. The other key ingredient was glue, which was placed over various layers of linen. The researchers chose to work with two simpler glues that would have been available everywhere: a glue made from the skins of rabbits and another from flax seeds.
Tests included shooting the resulting patches with arrows and hitting them with a variety of weapons including swords, axes and spears.

"Our controlled experiments basically dispelled the myth that armor made out of cloth must have been inferior to other available types. Indeed, the laminated layers function like an ancient version of modern Kevlar armor, using the flexibility of the fabric to disperse the force of the incoming arrow," Aldrete said.

Jan 10, 2010 by Rossella Lorenzi. http://news.discovery.com/history/ancient-egypt/linothorax-alexander-great-armor.htm

Automatic Lasso

BolaWrap 100 by Wrap Technologies

When police need to stop a suspect, they reach for electrified Tasers or resort to tackling. BolaWrap is a nonlethal and non-injuring tool to snare potential perps. The handheld device, based on the throwing weapon slung by South American gauchos, shoots an 7.7-foot-long Kevlar tether anywhere from 10 to 25 feet. The whip wraps around a suspect's legs two to three times—depending on their size—and two barbed pellets anchor themselves to clothing. Cops can load a new cartridge in seconds.

https://www.popsci.com/best-security-innovations-2018#page-2

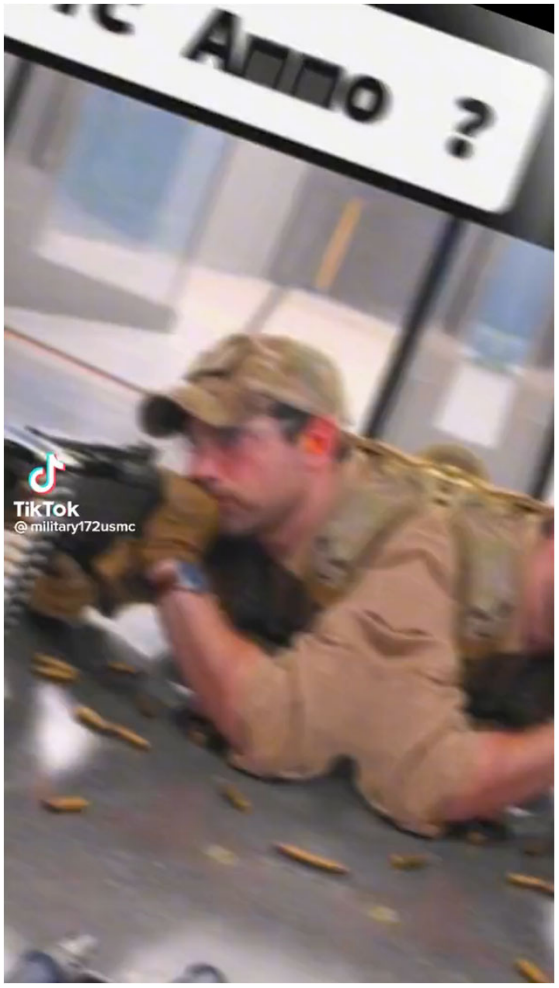
Plastic Gun and Ammo

There is now a “renewed threat” of downloadable guns “in the form of software or technology for the production of a firearm or firearm parts.” “Anyone with access to such files and a commercially available 3D printer could readily manufacture, possess, or transfer such a weapon,” the lawsuit says. “This will seriously compromise security in locations that rely on standard metal detectors.”

These “ghost guns” are unregistered, untraceable, often undetectable, and risk the lives of every American.
A 3D printed gun is a plastic firearm that can be downloaded and produced with a 3D printer. A person could also a 3D printer to make parts for a “ghost gun” which is a self-assembled firearm usually built from unregulated kits that are sold online. (By Josiah Bates)

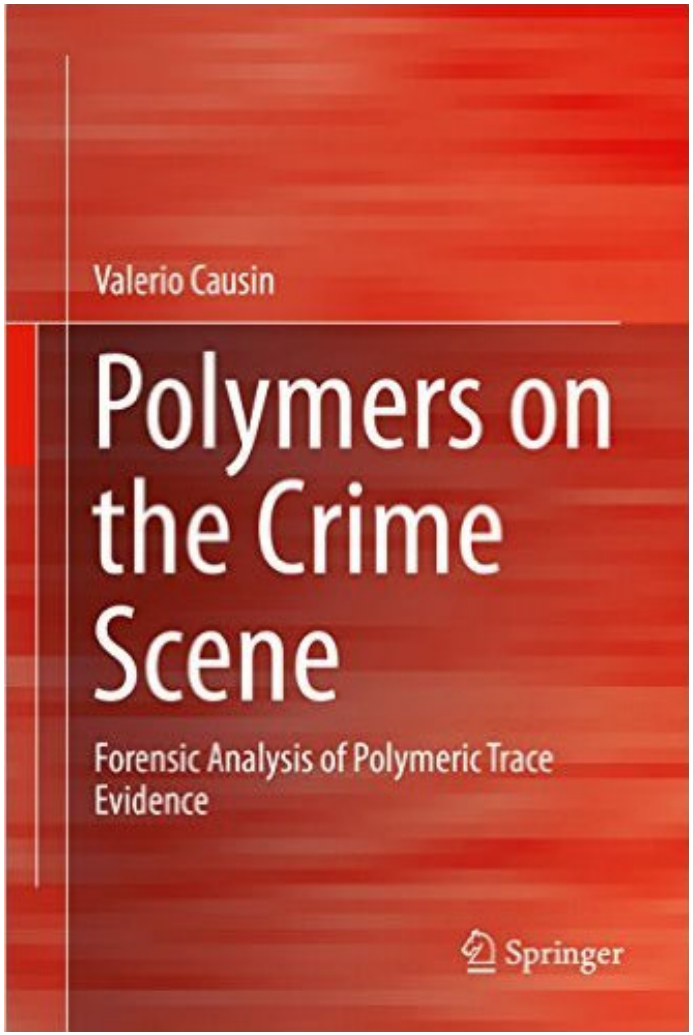
A 3D printed gun, seen in a factory in Austin, Texas on Aug. 1, 2018.
Kelly West—AFP/Getty Images

https://time.com/5770589/21-states-lawsuit-trump-printed-guns/?utm_source=newsletter&utm_medium=email&utm_campaign=the-brief-pm&utm_content=20200124&xid=newsletter-brief



https://www.tiktok.com/@military172usmc/video/7156232898033765678?_r=1&_t=8Wf86hVob4Y&is_from_webapp=v1&item_id=7156232898033765678

Polymers on the Crime Scene



Polymeric Traces: Transfer, Persistence, Recovery, Analysis and Interpretation of Analytical Data
Polymers on the Crime Scene
Formulation: Polymer Matrix, Fillers, Dyes, Pigments and Other Additives
Synthesis-Dependent Parameters: Molecular Weight, Constitution and Configuration
Processing-Dependent Parameters: Structure and Morphology of Polymeric Materials

> Criminalistics is an occupation that has all of the responsibilities of medicine, the intricacy of the law, and the universality of sciences—Paul L. Kirk, Ph.D. (1902–1970)

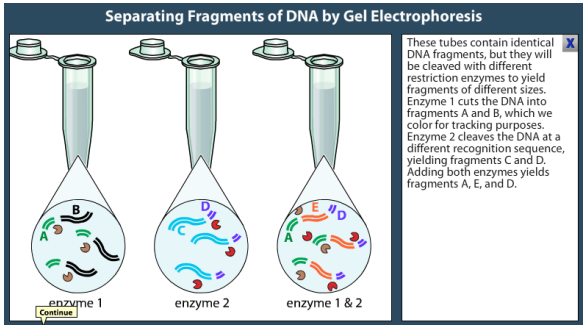
The words of Paul Kirk, one of the most eminent criminalists of the twentieth century, summarise the reason why forensic science elicits so much fascination. Criminalistics (or in its broadest sense forensic science) combines all those analytical and characterization techniques that support all the stakeholders in the judicial system in the investigation or explanation of crimes. As such, a vast array of scientific disciplines can be incorporated within it and, indeed, this comprehensiveness is its greatest strength.

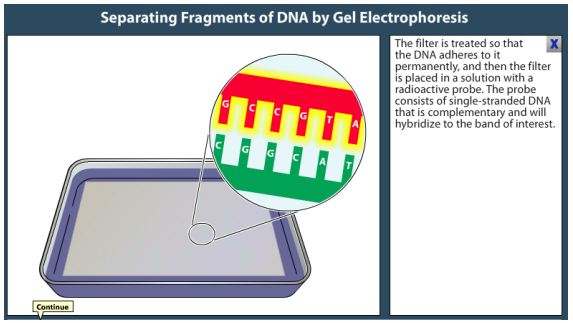
The arsenal of forensic science includes fields as diverse as meteorology, botany, entomology, molecular biology, chemistry, physics, psychology, and many more. The scientist, or more often a team of scientists, borrows strengths and capabilities of these various disciplines to analyse and interpret all the information contained in the remnants of a criminal act. The importance of science in apprehending suspects, adjudicating cases, and applying judgments is unparalleled among the various tools available to modern law enforcement.

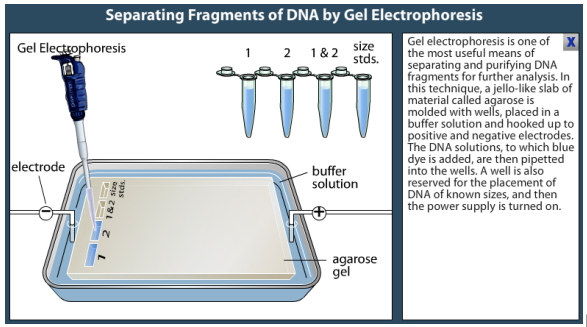
The general definition of forensic science is that it is 'science applied to the administration of justice'. However, this definition does not entirely reflect the peculiarity of this discipline. An emerging view within the scientific community identifies traces as the elements on which forensic science is based, leading to a definition of 'forensic science as the study of traces' [1]. Traces are the remnants of an activity [2], and they can be considered as the most basic 'material or physical' information on crime. This 'trace-centred' definition more clearly portrays the distinguishing features and implications of this discipline.

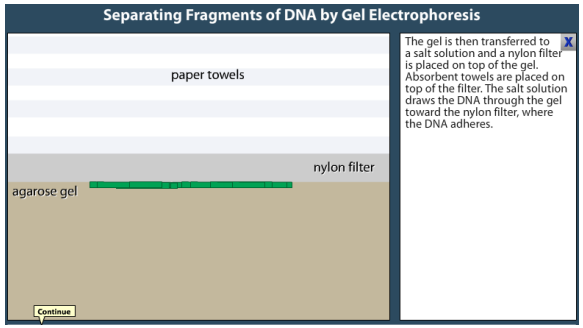
The possibility of identifying the source of a trace or to reconstruct how that trace was shed, and therefore the dynamics of a crime, are not only dependent on how the analytical process is carried out, but on a variety of information and circumstances that need to be assessed on a case-by-case basis. It is nevertheless out of question that the quality of analytical data obtained in the laboratory plays a crucial

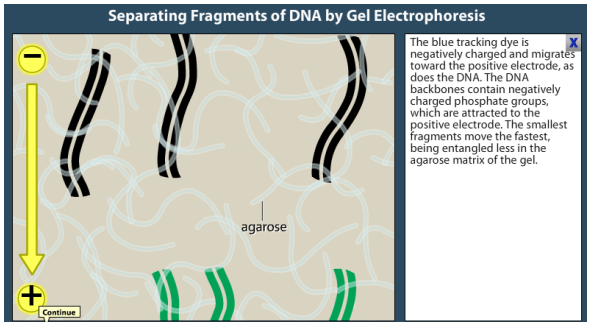
Agarose: Gel Electrophoresis for DNA Sequencing

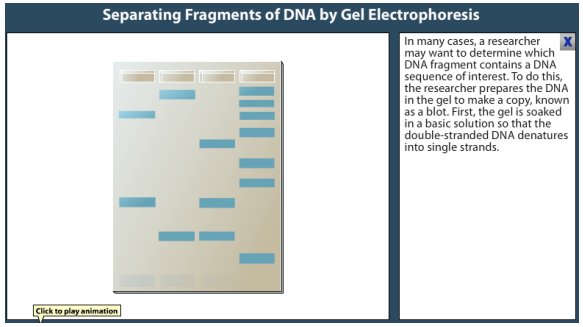


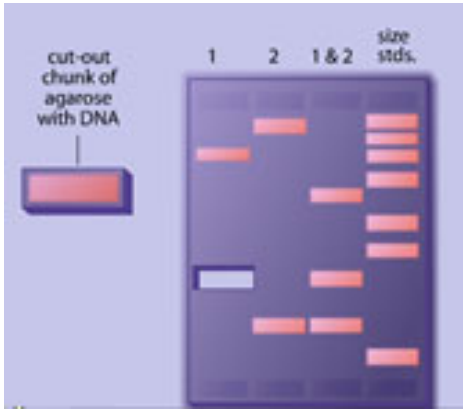












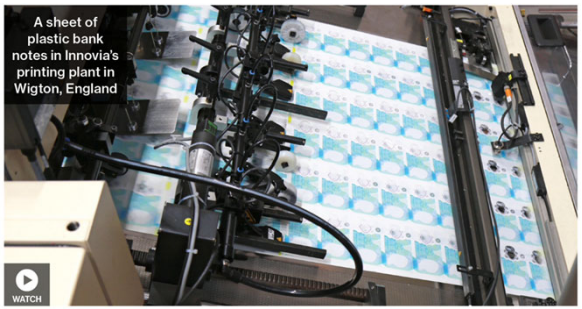
There have been 297 post-conviction DNA exonerations in the United States. The first DNA exoneration took place in 1989. Exonerations have been won in 36 states; since 2000, there have been 230 exonerations.

INNOCENCE PROJECT

http://www.sumanasinc.com/webcontent/animations/content/gelelectrophoresis.html

Polymers in Money

Plastic Banknotes



Photograph by Bank of England

A License to Print Plastic

▶ **Innovia dominates the growing market for polymer cash**

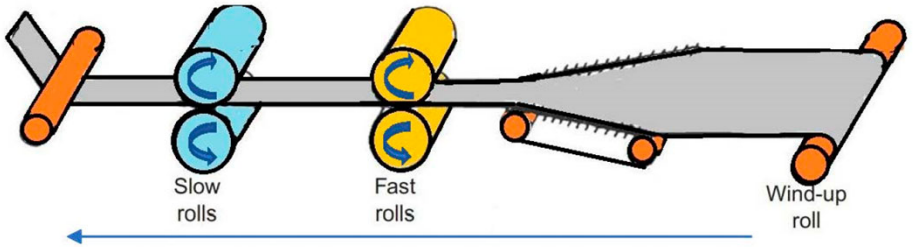
Mark Robertshaw is walking around a printing plant in Wigton, England, about 10 miles from the Scottish border, with a wad of cash. He lays out a Mexican 50, a Canadian 20, an Australian 5, and a fiver from the U.K. Unlike euros or U.S. dollars, these notes have a slight sheen and the feel of wax paper. That's because they entered the 10-story plant as popcorn-size kernels of plastic.

Plastic bills cost a few cents each to make, about twice the cost of paper, but they last five times as long, according to Robertshaw. "They can go through your washing machine," he says. "You can dip them in your wine." YouTube videos show the new £5 notes being used as a needle to play a vinyl record; others have shown that fire will melt them. "We don't claim they are indestructible," Robertshaw says.

Bloomberg Businessweek. November 7, 2016

Banknotes of the Australian dollar in a wallet. In 1988, Australia was the first country to introduce polymer banknotes for circulation.
https://en.wikipedia.org/wiki/Polymer_banknote

Biaxial-oriented polypropylene



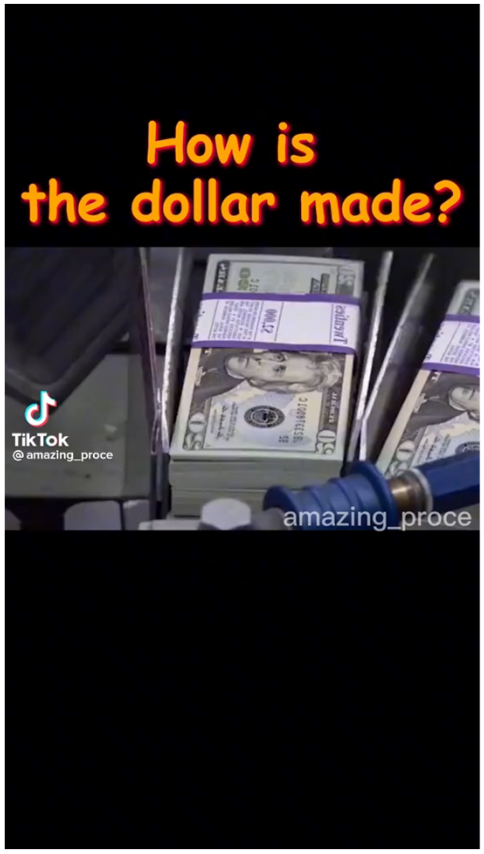
Paper

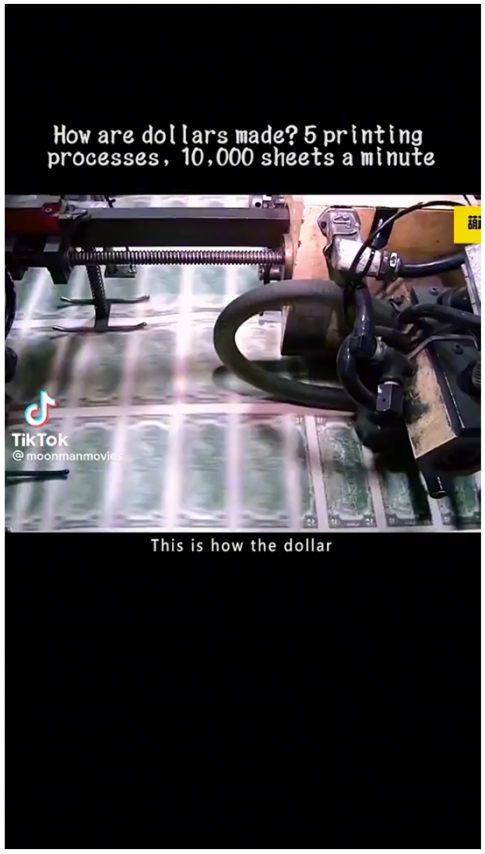
Polymer

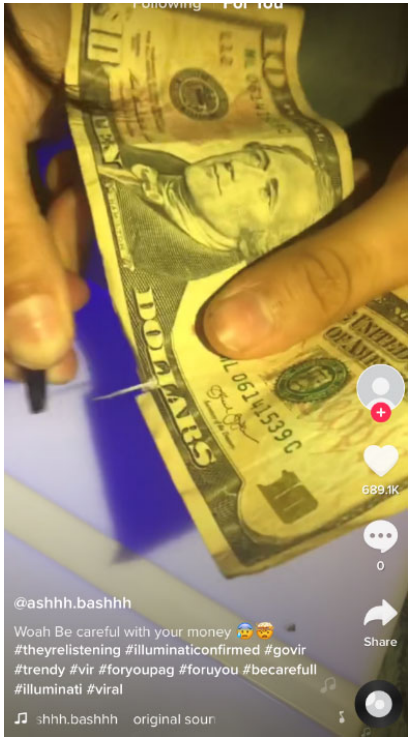
Transparent

Rafiei 2023, Polymer banknotes- A review of materials, design, and printing

Polymeric Banknotes: Cotton + Lignin







Polymers in Music

LP Vinyl

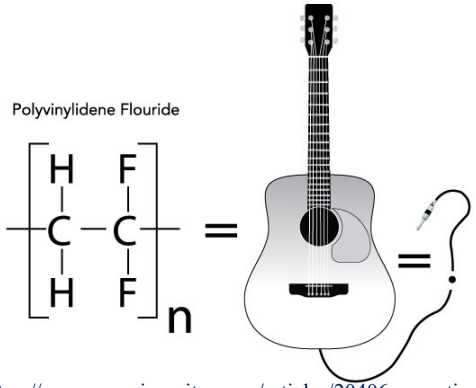
Trntbl comes in six colors and doesn't need to be plugged into speakers or a soundbar.

A Stylish, Wireless Vehicle for Vinyl

Sales of vinyl albums continue to climb — this year finally eclipsing CDs — so there's more reason than ever to make a style statement with Trntbl, which connects wirelessly to high-end speakers such as Sonos. Available in black, white, pink, yellow, forest green and gray, the turntable automatically pairs with the speaker when

Variety, Jan. 2020

Musical Strings



https://www.premierguitar.com/articles/20406-acoustic-soundboard-one-wordplastics

https://pslc.ws/macrog/kidsmac/polycons/strings.htm
http://www.aquimicadascoisas.org/en/?episodio=the-chemistry-of-musical-instruments
https://en.wikipedia.org/wiki/String_(music)

Original strings were made from large animal intestine, sheep gut, or cow intestine (cat gut).

- Preserve using salt and sodium carbonate.
- The intestine becomes like a rope, fine strings assembled together.
- Preserve by soaking in a series of chemicals.
- Bleaching, tannin adhesive.
- Combine separate strings into one strong string.
- Twist the strings.
- Dry the gut strings in humidity controlled room.
- As it dries, collagen acts like glue and bind strings together.
- Strings can absorb moisture and swell. To prevent this, a sponge (natural) is used to coat the strings with Marine varnish.

https://www.youtube.com/watch?v=wRQq_0VM110

Polymers in Packaging

Plastic Packaging History

1930 1940 1950 1960 1970 1980 1990 2000 2010 2020

1862
Parkesine (Cellulose-based)

1900s
Cellophane

1930
Scotch tape (Cellophane)

1933
Polyvinylidene chloride (Saran™)

1946
Tupperware®
(Polyethylene)

1946
Stopette®
(Squeezing plastic bottle, Polyethylene)

1950
Garbage bag
(Polyethylene)

1954 Ziploc®
(Polyethylene)

1959
Lunch box
(Polypropylene)

1960
Bubble Wrap®

1986
TV Dinners (microwavable plastic tray, Polypropylene)

1988
Resin ID coding system
(Polypropylene)

1996
Salad in a bag
(Polyethylene, polypropylene)

2000
Yogurt in flexible plastic tubes (PP)

2000
Poly(lactic acid) (PLA) made from corn

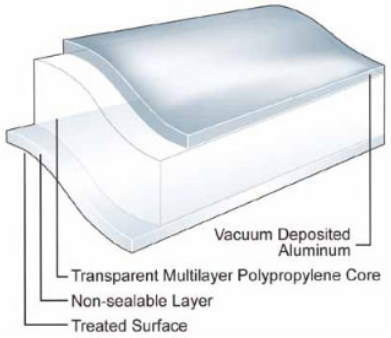
2004
Polyethylene (Saran™)

2007
2 L plastic beverage bottles

2008
27% recycling of plastics

2010
Metallyte™ films
PP + Metal layer

2010
Heinz® Dip & Squeeze
(Polyethylene)



Metallyte film offers a super moisture barrier.
https://www.jindalfilms.com/wp-content/uploads/jindal-products/productinfo/12mm281_fact_sheet.pdf

https://www.plasticsmakeitpossible.com/about-plastics/history-of-plastics/plastic-innovations-in-packaging-through-the-decades/
https://www.cosmeticsandskin.com/ded/stopette.php

Bento Orders

SOCIAL GOOD

Help for the Hungry

Bento

By Guadalupe Gonzalez

TIME 100 inventions 2021

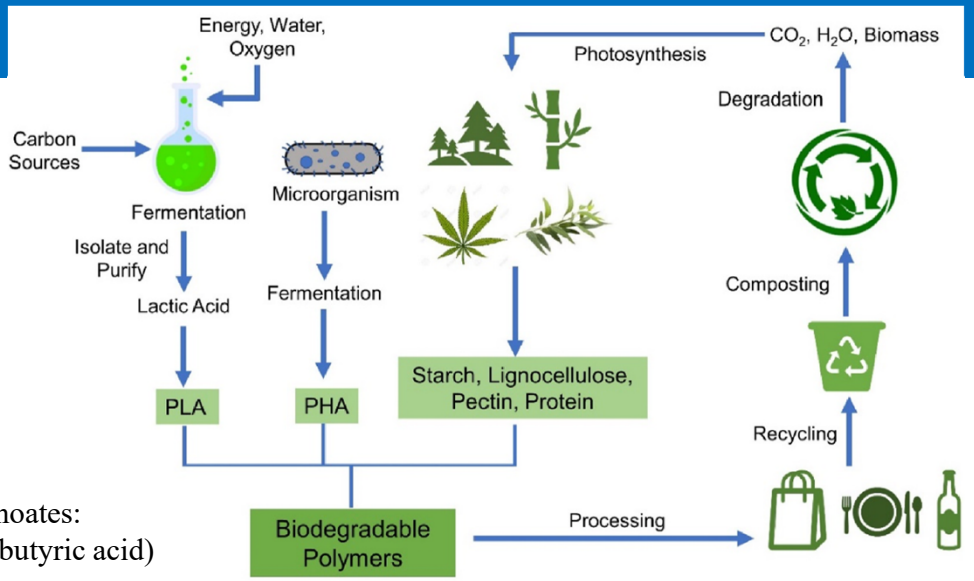
When Mick Ebeling set out to tackle the food-insecurity crisis that affects 1 in 8 Americans, he envisioned something useful and convenient that could also protect users' dignity. The answer: cell phones-more specifically, a text-messaging service called Bento that partners with local organizations and government agencies to enroll people in need of food assistance. Once signed up, users can text "hungry" to a number associated with the service. They can then select a no-cost meal from nearby participating restaurants, which process Bento orders as they would any other-allowing users to pick up their meals without drawing attention to their situation. Bento has provided 150,000 healthy meals since its launch in March 2020, Ebeling says.

When Mick Ebeling set out to tackle the food-insecurity crisis that affects 1 in 8 Americans, he envisioned something useful and convenient that could also protect users' dignity. The answer: cell phones—more specifically, a text-messaging service called Bento that partners with local organizations and government agencies to enroll people in need of food assistance. Once signed up, users can text “hungry” to a number associated with the service. They can then select a no-cost meal from nearby participating restaurants, which process Bento orders as they would any other—allowing users to pick up their meals without drawing attention to their situation. Bento has provided 150,000 healthy meals since its launch in March 2020, Ebeling says.

Sustainable Packaging of Food Products

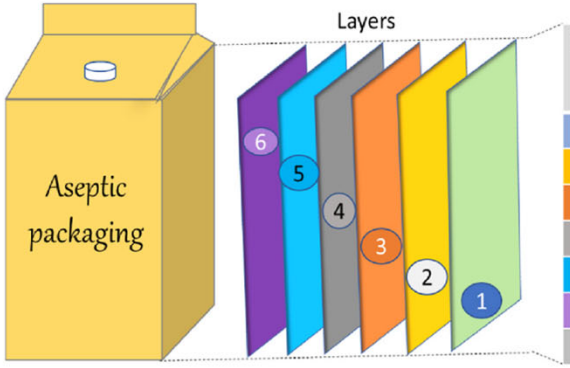
Table 1
Barrier properties of petroleum and bio-based paper coatings.

Coating material	WVP [g. mm/m^2/day]	OP [cm^3. mm/m^2/day/atm]	OGR (Kit #)	Applications
Petro-Based polymers				
High Density Polyethylene (HDPE)	0.1–0.24	26.3–453	–	Bottles for milk and fruit juices, caps for bottled beverage
Low Density Polyethylene (LDPE)	0.39–0.59	98–453	–	Bottles for milk and fruit juices, caps for bottled beverage, packaging films for frozen and dry foods
PET	0.28	55	–	Bottles for beverages, salad dressings, cooking oils and peanut butter
Metalized PET	0.04–0.10	0.16–1.7	6	Yogurt and coffee container
EVOH	0.8–2.4	0.01–0.15	–	Employed with PE/PET/PS for packaging meat, fish, cheese, nut, desserts and alcoholic beverages
PVC	0.94–0.95	3.28–394	–	Films are used for meat and vegetable wrapping, bottles are used for juice and cooking oil
Polyvinylidene Chloride (PVDC)	0.025–0.913	0.00425–0.57	–	Films are used for meat, poultry, confectionary and vegetables packaging
Saran PVDC Films	0.009–0.34	0.00425–0.00625	–	Wrapping films for meat, poultry, seafood cooked food packaging
Poly Propylene (PP)	3.9–6.2	35–377	–	Meat, poultry and confectionary packaging
Metalized OPP	0.01–0.03	0.019–0.16	–	Snacks, confectionary, nuts and coffee products
Nylon-6	0.24–125	0.394–2.50	–	Processed meat packaging
Metalized Nylon-6	0.1–0.15	0.00078	–	–
Polystyrene	109–155	4350–6200	–	Egg cartoons
Polytetrafluoroethylene (PTFE)	0.0045–0.30	222–387	12	Not directly used in food packaging; widely used for coating belts and conveyors in food processing industries for eggs, bacon, sausage, chicken and industrial bakeries
Bio-Based & Bio-degradable polymers				
Cellulose acetate	4.5–77.85	0.239–1.301		Fresh food baked goods, candy packaging
Starches	1.06–2.83	0.01–0.014	–	Wraps for fruits, vegetables, red meat
Soy Protein	3.5–4.5	0.94–2.56	–	Films, coating on paper for fruits and vegetable packaging
Pectin	113	2.4	–	Films, coating on paper for cheese, milk powder and beverage
Chitosan	1.28–21	0.2–9.8	–	Films for fresh fruits and vegetables, bread packaging
PLA	1.34	0.038–0.042	12	Films for fresh fruit, vegetables, salad and chicken meat packaging
PVOH	41.904	0.1–45	–	Packaging for cheese, coffee, nut products eggs and ice-cream
PHB	0.23	0.42	–	Cheese coatings, water bottles, Mayonnaise containers
CNF	17.0	0.3	–	–
Modified CNF	17.0	0.003	5–8	–
CNC-MMT-Soy	20	0.28	6	Fresh food packaging, baked goods packaging
CNF/CNC-MMT-Soy	17.8	0.03	11	–



PHA: Polyhydroxyalkanoates:
PHB: poly(3-hydroxybutyric acid)

Fig. 2. Schematic illustration of recyclable process of biodegradable polymers.



Layers	Function	Conventional material	New develop-ments
1	Protect against outside moisture	PE	Bio-PE
2	For stability and strength	paperboard	Paperboard
3	Adhesion layer	PE	PE
4	Oxygen flavor and light barrier	Aluminum foil	Aluminum
5	Adhesion layer	PE	PE
6	Seals in liquid	PE	PE
Cap		HDPE	Bio-HDPE

Fig. 4. Paperboard-based aseptic packaging layered structure.

Tyagi 2021, Advances in barrier coatings and film technologies for achieving sustainable packaging of food products

BioPackaging

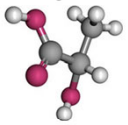
Bags made out of plastic, like grocery bags, have been used everyday for years. The plastic used in these bags is bio-inert. This means it does not react to biological tissues, or it do not break down easily.

Mater-Bi. BioBag® products are made from starch, plant-based polymers and other renewable resources. No polyethylene is used in the production process.

Starch → PLA

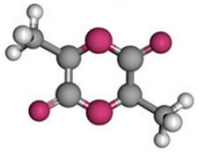
Grow plants like corn, cassava, sugar cane or beets.

⇩



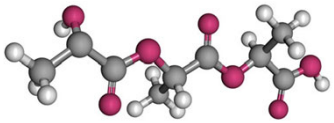
Convert glucose (of starch) to lactic acid.

⇩



Transform lactic acid to lactide.

⇩



Polymerize lactide into polylactide (PLA)

http://www.biomasspackaging.com/brands/biobag/
http://www.biomasspackaging.com/education/bioplastics/
https://www.natureworksllc.com/What-is-Ingeo/How-Ingeo-is-Made

EcoSafe 6400 products are 100% compostable. EcoSafe 6400 trash can liners are made with the environment in mind. Using co-polyester and corn starch, the trash can liners are bio-degradable. Naturally occurring, co-polyester allows EcoSafe bags to degrade faster than bags made from other materials.

DW Fine Pack was one of the first companies in North America to introduce, disposable foodservice packaging products made from NatureWorks® Ingeo™— a biopolymer made from 100% renewable resources. DW Fine Pack branded their bioplastic material as NaturesPLAstic®, and subsequently developed several product lines with unique, superior qualities well suited to the industry.

Food Packaging Materials: Bio-sourced Polymers

Fig. 3. Typical food Packaging materials from Bio-sourced origin (Grujić et al., 2017, pp. 139–160; Luzi et al., 2019).

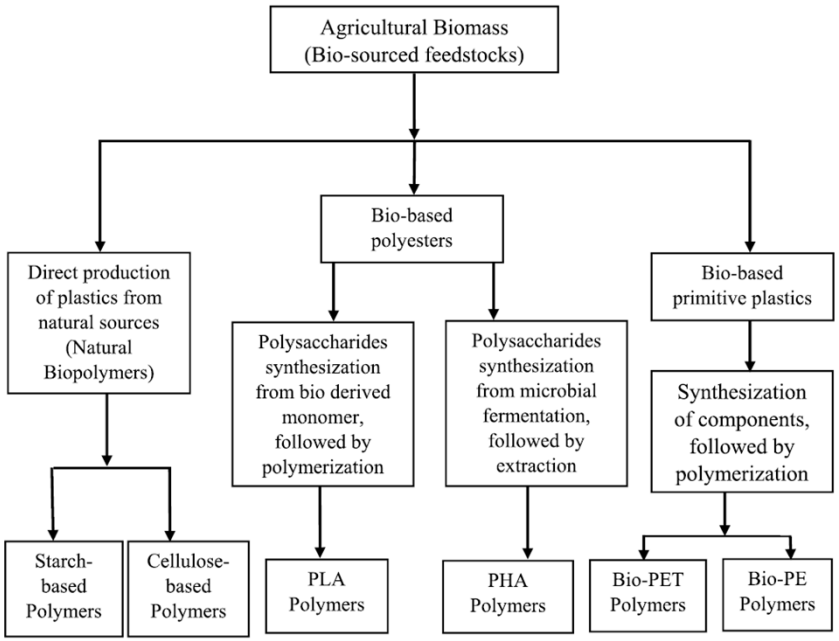
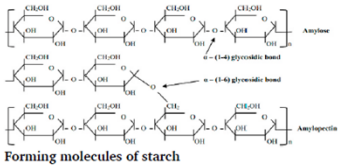
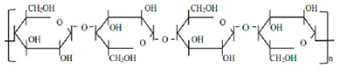
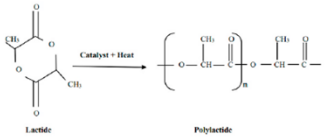
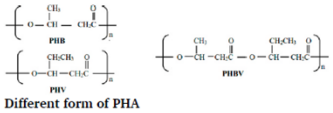
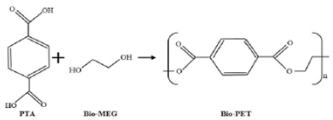
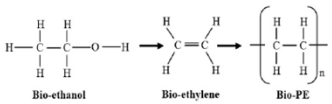


Table 5
Overview of bio-sourced plastics: Alternatives to conventional food packaging.

Bio-sourced Polymers		Chemical structures	Possible substitutes	Raw materials
Natural biopolymers	Starch-based polymers	 Forming molecules of starch	PS	Potato, rice, corn, cassava, tapioca, starch from potato, wheat, barley, oats and soy sources
	Cellulose-based polymers	 Structure of cellulose	LDPE, HDPE, PS, and PP	Fiber, herbaceous crops, cotton or wood pulp, and wood chips
Bio-based polyesters	PLA polymers	 Conversion of PLA	PS, LDPE, PET, and HDPE	Maize, wheat, cassava, corn starch, sugar crops like sugarcane, bagasse, wheat straw, corn stover, wood chips, as well as methane fermentation from PLA waste
	PHA polymers	 Different form of PHA	PE and PP	Sunflower, olive, soy, rapeseed, sugar cane, and palm oil residues
Bio-based primitive plastics	Bio-PET polymers	 Formation of Bio-PET	PET	Sugarcane, sugar beet, bagasse, molasses, and hay
	Bio-PE polymers	 Formation of Bio-PE	PE	Sugarcane and sugar beet

Sid 2021, Bio-sourced polymers as alternatives to conventional food packaging materials

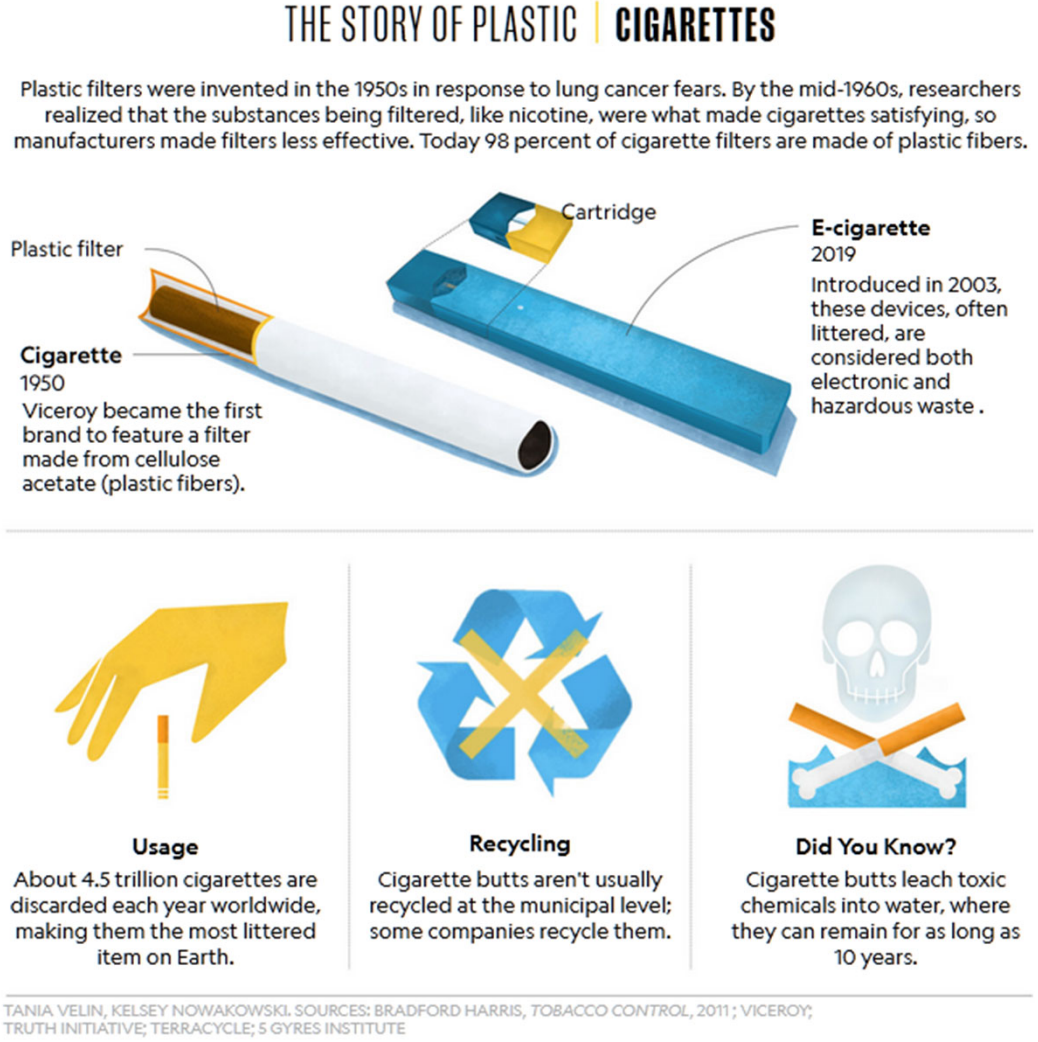
Cigarette Filters (Butts or Ends)

What's the world's most littered plastic item?
Cigarette butts

Cigarette filters are the “last acceptable form of littering,” but there are solutions that can help our health and planet. (Tik Root, 2019)

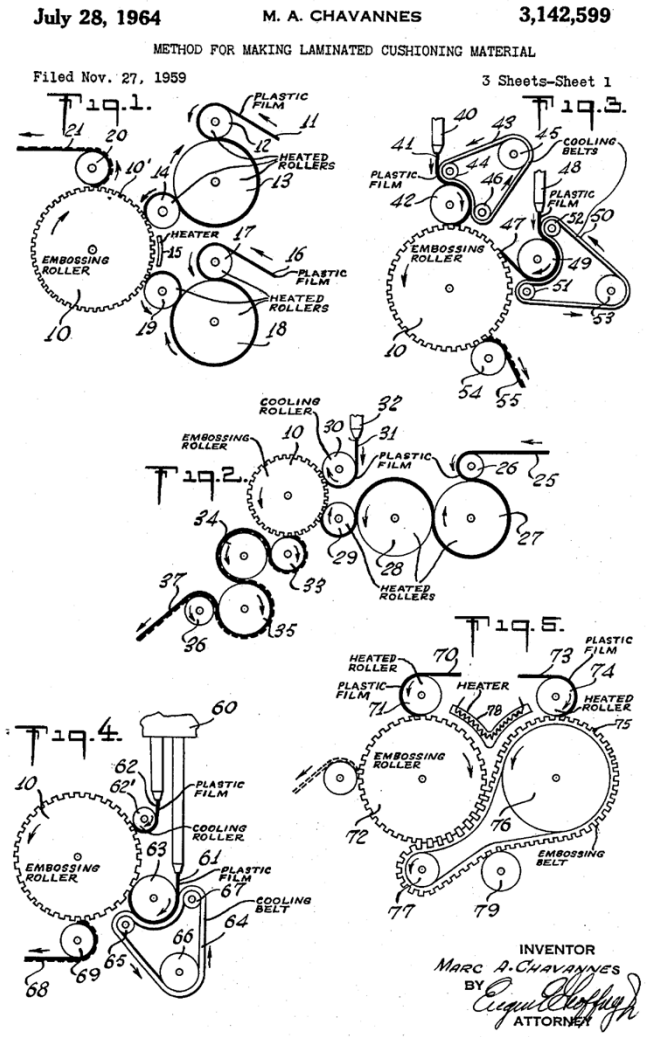
Smokers around the world buy roughly 6.5 trillion cigarettes each year. That’s 18 billion every day. Cigarette filters are made of a plastic called cellulose acetate (used for making films). When tossed into the environment, they dump not only that plastic, but also the nicotine, heavy metals, and many other chemicals they’ve absorbed into the surrounding environment.

https://www.nationalgeographic.com/environment/article/cigarettes-story-of-plastic



Bubble Wrap

Cavaganes 1964, Method for maeng laminated cushioning material



United States Patent Office

3,142,599
Patented July 28, 1964

1

3,142,599
METHOD FOR MAKING LAMINATED CUSHIONING MATERIAL
Marc A. Chavannes, Brooklyn, N.Y., assignor to Sealed Air Corporation, Hawthorne, N.J.
Filed Nov. 27, 1959, Ser. No. 855,712
5 Claims. (Cl. 156—210)

2

of other known materials affording equivalent characteristics.

The above and other objects and advantages of the invention will become more apparent from the following description and accompanying drawings forming part of this application.

In the drawings:

What is claimed is: 1. The method for continuous fabrication of cushioning material comprising the steps of heating a plastic film having thermoplastic characteristics to an embossing temperature above the softening temperature but below the melting point thereof, feeding said heated film onto a female molding roller having discrete depressions dis tributed throughout the surface thereof with the peripheral edges of the depressions being spaced one from the others, forming said film into said depressions to produce embossments extending from one surface there of, heating at least one surface of a second film having thermoplastic characteristics to a temperature in the vicinity of the melting point thereof, applying the heated surface of the second film to the first film on the molding roller while the exposed surface of said first film is at a temperature in the vicinity of its melting point to fuse the films one to the other and hermetically seal said embossments and then removing the fused films from said molding roller.

Bubble Wrap

Issue 154

How It Works reveals the 12 unbelievable inventions that started life as something else, how to spot meningitis and save a life, the chemistry of your cuppa, plus much more

BUBBLE WRAP WALLPAPER

Bubble wrap is synonymous with sending packages or protecting your precious belongings. However, in the 1950s you were more likely to see it covering your walls than crammed into a box. The idea for bubble wrap came from the minds of Alfred Fielding and Marc Chavannes, who made an attempt to create a textured wallpaper in 1957. Having heated two sheets of plastic shower curtain together, the pair created a single sheet with several trapped air bubbles.

The coinventors obtained several patents for their creation, making attempts to market it as wallpaper and even as greenhouse insulation, but bubble wrap never took off as an interior decoration. The two coinventors founded Sealed Air Corporation in 1960, and the following year diversified their product as a packing material, which soon found success.

MR CELLOPHANE

In the kitchen drawers of countless homes around the world, you'll probably find a roll of cling film, or Cellophane. This clear roll of plastic has been around since 1908, when Swiss chemist Jacques E. Brandenberger created a waterproof film intended for coating fabrics. The film appeared after Brandenberger applied a liquid viscose rayon on materials and then peeled away the transparent layer. He saw potential for this new material in the packaging industry, and so patented his creation 'Cellophane', named after the raw material cellulose – the main substance of plant cell walls – and diaphane, an obsolete word meaning transparent.

PLAY-DOH CLEANER

Around 318 million kilograms of Play-Doh has been squashed between the fingers of children around the world. But did you know that Play-Doh was initially invented as a cleaning tool, rather than a toy? The malleable material was created by Cincinnati-based cleaning company Kutol in the early 1900s. Its intended use was to remove the soot from people's wallpaper, which accumulated from coal-burning fireplaces. However, with the introduction of wipeable vinyl wallpaper and the increase in household oil, gas and electric heating, the need for Kutol's putty quickly declined. Its rebranding was down to the sister-in-law of Kutol's cofounder, who proposed that the putty's non-toxic ingredients meant it would be perfect for playtime.

Instapak Foams

What is Instapak made of?
Instapak consists of a polyethylene film bag, made from Sealed Air's Instamate® film, designed for high strength and flexibility, that holds a liquid polyurethane foam that can expand up to 200 times its liquid volume.

Liquid foam spray

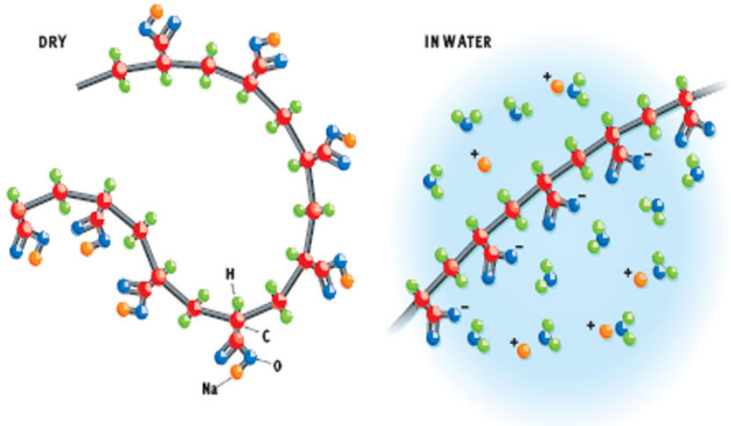
https://www.google.com/search?client=firefox-b-1-d&q=How+to+make+a+packaging+box+for+liquid+styrofoam#fpstate=ive&vld=cid:a3fa2060,vid:QK0FIC3pnuA

Polymers in Cold & Hot Packs

Ingredients in Cold Packs

The 9 primary ingredients of children's gel packs

1. Propylene glycol
This compound of viscous, odourless and colourless liquid is used as a synthetic food additive. Being in the same chemical group as alcohol, this compound dissolves better than water and is great at retaining moisture. Various food and beverage products use propylene glycol as an anti-caking agent, an emulsifier, stabilizer, thickener and dough strengthener, among other applications.
2. **Hydroxyethyl cellulose**
Made from pine and spruce tree trunk-derived gum, this compound is mainly a thickening and gelling agent used in cosmetics, cleaning compounds and other household products. This substance helps hold the pack's gel-like form and is responsible for its reusability.
3. Vinyl-coated silica gel
This essential gel pack additive holds the ingredients together and retains the cold temperature once you remove the pack from the freezer. Silica gel is made synthetically from silicon dioxide and is generally non-toxic, according to the NCPC.
4. **Sodium polyacrylate**
This compound is a thickener and can absorb as well as hold on to water molecules, making it the top choice as a thickening agent. This chemical likewise increases the stability and viscosity of water-based compounds.
5. Non-toxic blue dye
Jacob Spencer first filed a patent for a reusable gel pack in 1971. He was also responsible for the pack's peacock-blue coloring that's still carried by most manufacturers to this day.
6. Ammonium Nitrate
Responsible for cooling the pack and producing the cold temperature, this compound is highly water-soluble and is used as an explosive. In its white, solid crystal form, it can cause irritation to the skin upon contact. Because of its possible application as an explosive, the U.S. sought to regulate its use by passing the Ammonium Nitrate Security Act in 2005. This drastically led to the reduction of ammonium nitrate makers and suppliers.
7. Urea
You may be more familiar with this chemical being used as a fertilizer, but urea is also used in instant cold packs to create an endothermic, or heat-absorbing reaction.
8. Ammonium Chloride
Some reformulated versions of instant cold packs use ammonium chloride, which is deemed safer than ammonium nitrate. This chemical compound is used in cold medicines for humans and to rid of urinary stones in goats, cattle and sheep. It can be hazardous in its solid or gas form, though.
9. Water
Both reusable and instant cold packs contain water and it is, perhaps, the major component of both types of packs. It goes without saying that water is non-toxic and safe, unless mixed with hazardous compounds and unintentionally ingested.



SODIUM POLYACRYLATE has sodium carboxylate groups hanging off the main chain. In contact with water the sodium detaches, leaving only carboxyl ions. Being negatively charged, these ions repel one another so that the polymer unwinds and absorbs water, which is attracted to the sodium atoms. The polymer also has weak cross-links, which effectively leads to a three-dimensional structure. In addition, it has molecular weights of more than a million; thus, it cannot dissolve but instead solidifies into a gel.

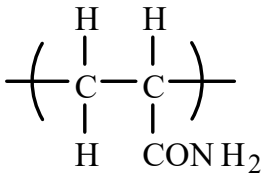
Stretton 2020, https://gelpacks.com/diy/the-9-primary-ingredients-of-childrens-gel-packs-and-their-potential-side-effects/?v=7516fd43adaa

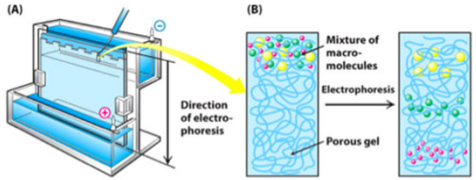
Ingredients in Cold Packs

Supplies for Cold Packs

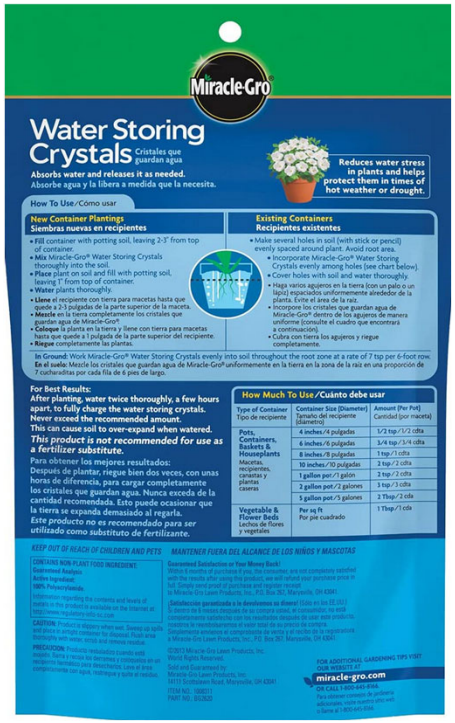
- Water (Plain water works but distilled water is the purest and will not discolor over time.)
- Rubbing Alcohol (Keeps it from freezing solid.)
- Ziploc Type Bags. Freezer type will of course last the longest.
- Food Coloring
- Water Crystals
- Iron and foil for sealing bag closed.
- Material for Pouch

Nancy, https://craftyourhappiness.com/2014/07/24/diy-cold-packs-tutorial-pretty-easy/





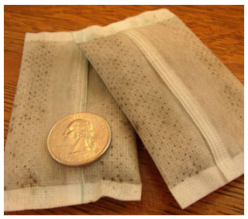
Water Crystals: Crosslinked **polyacrylamide** gel particles



Hot Packs

Iron Powder

Disposable chemical pads employ a one-time exothermic chemical reaction. One type, frequently used for hand warmers, is triggered by unwrapping an air-tight packet containing slightly moist iron powder and salt or catalysts which rusts over a period of hours after being exposed to oxygen in the air.



Calcium Chloride

Another type contains separate compartments within the pad; when the user squeezes the pad, a barrier ruptures and the compartments mix, producing heat such as the enthalpy change of solution of calcium chloride dissolving.

Magnesium Sulfate

Sodium Acetate Trihydrate

The most common reusable heat pads contain a supersaturated solution of sodium acetate in water. The sodium acetate, upon interaction with a metal, crystalizes on the metal to release heat. To initiate the reaction, flex a metal.

Crystallization is triggered by flexing a small flat disc of notched ferrous metal embedded in the liquid. Pressing the disc releases very tiny adhered crystals of sodium acetate [Rogerson 20004, Solidification in heat packs: III. Metallic triger, AlChE J.] into the solution which then act as nucleation sites for the crystallization of the sodium acetate into the hydrated salt (sodium acetate trihydrate, $CH_3COONa \cdot 3H_2O$). Because the liquid is supersaturated, this makes the solution crystallizes suddenly, thereby releasing the energy of the crystal lattice. The use of the metal disc was invented in 1978 [Stanley 1978, Reusable heat pack containing supercooled solution, US4077390]. The pad can be reused by placing it in boiling water for 10–15 minutes, which redissolves the sodium acetate trihydrate in the contained water and recreates a supersaturated solution. Once the pad has returned to room temperature it can be triggered again. Triggering the pad before it has reached room temperature results in the pad reaching a lower peak temperature, as compared to waiting until it had completely cooled

https://preparednessmama.com/hot-pack/
https://en.wikipedia.org/wiki/Heating_pad
https://sciencing.com/make-salt-crystallize-8686035.html
https://www.teachersource.com/product/chemical-heat-pack?gclid=EAIaIQobChMIsLDI5biN9QIVzBXUAR1znQnVEAsYCCABEgKPZfD_BwE

Jelly Ice Cubes: Gelatin-Based Hydrogel as Food Coolant

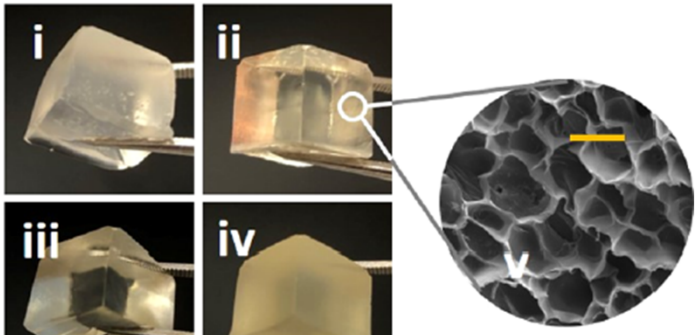


Figure 2. (a) Appearances of hydrogels with 5% (i), 10% (ii), 15% (iii), and 20% (iv) gelatin under room temperature.

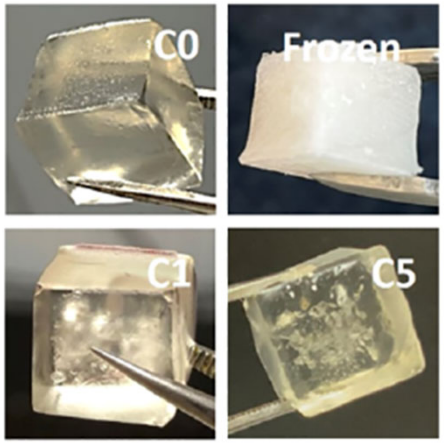


Figure 3. (a) Appearances of gelatin hydrogel JICs under ambient conditions (C0, no FT treatments; C1, after one FTC; C5, after five FTCs) and frozen status.

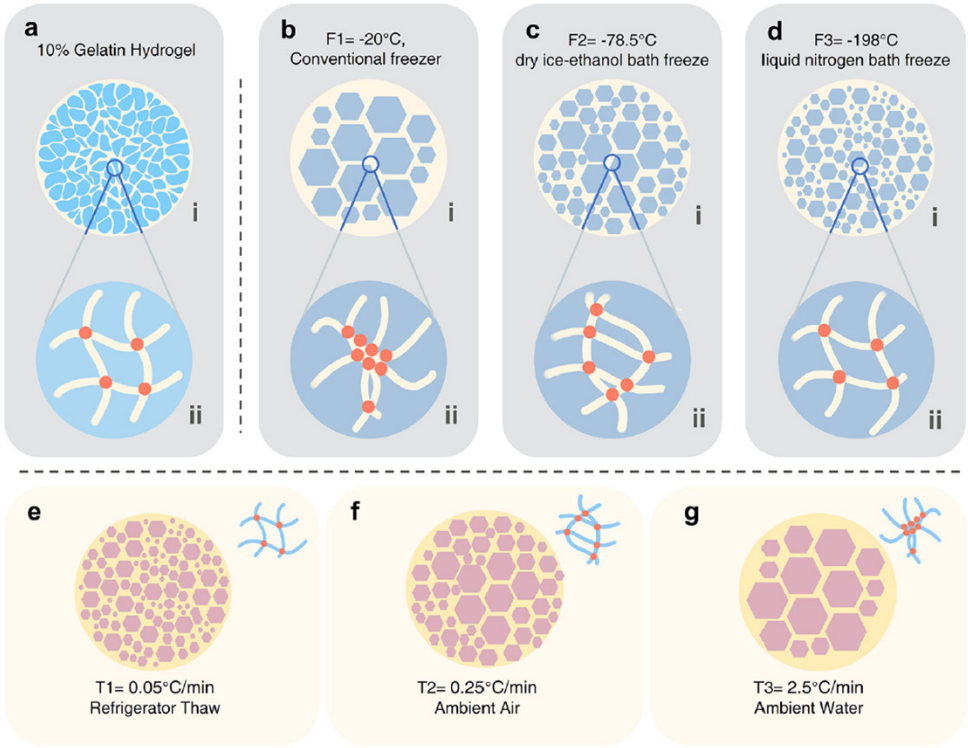


Figure 5. Schematic drawing on the freeze−thaw effect to the structures of JICs under different FT conditions. (a) 10% gelatin hydrogels under room temperature before FT treatments. JICs frozen at −20 °C (b), −78.5 °C (c), and −198 °C (d). JICs thawed at −20 °C (e), −78.5 °C (f), and −198 °C (g). The water and ice fractions are shown in either blue (fresh or frozen, a−d) or pink (thawed, e−g). The portion of protein polymers is shown in either ivory (a−d) or yellow (e−g). Orange dots represent the possible cross-linking spots within the polymer network. The status of polymer macronetworks under a thawed status is also shown in the top right corner in blue with orange cross-linking spots in parts e−g.

Zou 2021, Sustainable and reusable gelatin-based hydrogel jelly ice cubes as food coolant. I: I: Feasibilities and Challenges
Zou 2021, Sustainable and reusable gelatin-based hydrogel “jelly ice cubes” as food coolant. II: Ideal Freeze−Thaw Conditions

Polymers in Personal Care

Just Add Water

TIME 100 Inventions 2021

Inspired by the emerging (and environmentally friendly) trend of water-activated tablets in home-care items., Everist co-founders Jessica Stevenson and Jayme Jenkins decided to apply the concept to hair care. Everist's shampoo and conditioner ($24 each) come in a paste format that turns into a foamy lather and serum-like conditioner when activated by water. While the 100 mL tube might appear tiny, it's equivalent to a size 300 mL bottle of shampoo.

NOVEMBER 22, 2021

BEAUTY

Just Add Water

Everist Waterless Haircare Concentrates

By Taylor Bryant

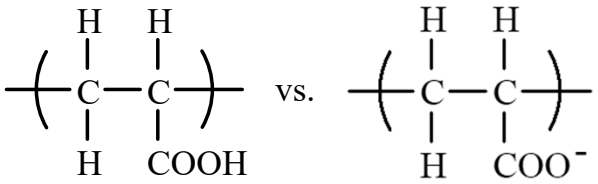
Inspired by the emerging (and environmentally friendly) trend of water-activated tablets in home-care items, Everist co-founders Jessica Stevenson and Jayme Jenkins decided to apply the concept to hair care. Everist's shampoo and conditioner ($24 each) come in a paste format that turns into a foamy lather and serum-like conditioner when activated by water. While the 100 ml tube might appear tiny, it's equivalent to a
ize 300 ml bottle of shampoo.

Contents
NOVEMBER 22, 2021

Poly(acrylic acid)

Poly(acrylic acid) as a super-absorbent (SAP) was patented in 1966 by Gene Harper of Dow Chemical and Carlyle Harmon of Johnson & Johnson. It was first used in diapers in 1982 in Japan.
http://toxipedia.org/display/toxipedia/Polyacrylic+Acid

Patented in 1966



pH

Working Knowledge

DIAPERS_DISPOSABLE

Superabsorbers

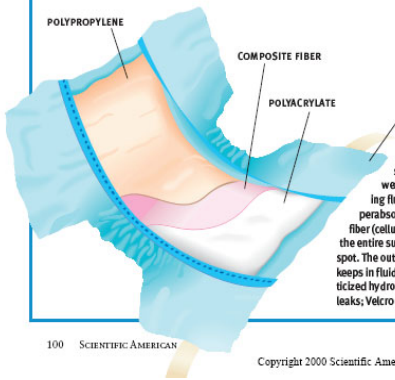
If you've taken a diaper off a baby sometime in the past decade, you were probably surprised—not at how messy it is, but at how heavy it is. Today's disposable diapers can hold pounds of pee and still feel quite dry, which may be why fewer than 5 percent of American babies use cloth diapers.

This astonishing absorbency comes from a family of hydrophilic ("water-loving") polymers called polyacrylates. Perhaps the simplest of these is sodium polyacrylate, which can hold 800 times its weight in distilled water. Of course, there's more to urine than water. Dissolved salts and ions reduce the absorbency by more than a factor of 10. The leading brands of diapers use combinations of polyacrylates that presumably do better—but it might be easier to find the recipe for an atom bomb than for a diaper filling. It's a competitive industry.

Because they keep the skin drier than cloth, disposable diapers are probably better for baby, although the margin is unclear in practice—babies in cloth diapers are changed more often and don't have seem to have diaper rash more frequently. Advocates of cloth diapers point to the enormous environmental cost of disposables. The overall environmental equation of washable versus disposable diapers is hard to quantify, but the latter form a significant chunk of the urban waste stream. Disposable diapers add about 2.7 million metric tons of pee, poop, plastic and paper to U.S. landfills every year.

In tropical countries, babies often go diaper-free; it's cheaper just to mop up the floor. In fact, as this mother was informed (sometimes by virtual strangers) during a visit to India, it's considered cruel and unusual treatment to subject a baby to the breezeless confinement of a diaper. Result: no rash and no trash.

—*Madhusree Mukerjee, staff writer*



MOST MATERIALS used in a disposable diaper are synthetic. Polypropylene, used in winter athletic underwear, makes up the inner layer; it is soft and stays dry, drawing fluid away from the skin. At the core is the polyacrylate superabsorbent powder, combined with fluffy cellulose. A layer of fiber (cellulose or synthetic) fights gravity by distributing fluid over the entire surface of the powder instead of letting it pool in one spot. The outermost layer is mostly microporous polyethylene; it keeps in fluid but lets out vapor. Adhesives hold it all together: elasticized hydrophobic polypropylene cuffs around the thighs contain leaks; Velcro or sticky tabs hold the diaper on the baby.

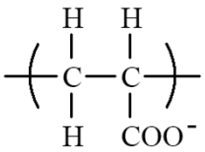
SODIUM POLYACRYLATE has sodium carboxylate groups hanging off the main chain. In contact with water the sodium detaches, leaving only carboxyl ions. Being negatively charged, these ions repel one another so that the polymer unwinds and absorbs water, which is attracted to the sodium atoms. The polymer also has weak cross-links, which effectively leads to a three-dimensional structure. In addition, it has molecular weights of more than a million; thus, it cannot dissolve but instead solidifies into a gel.

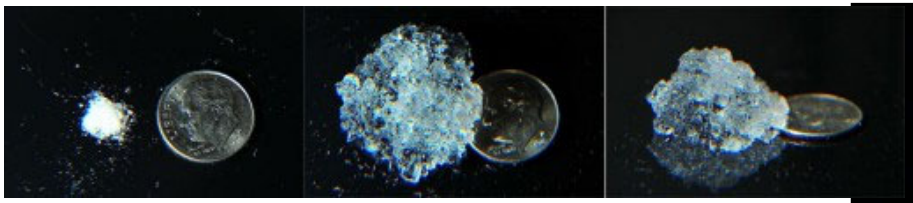
DID YOU KNOW...

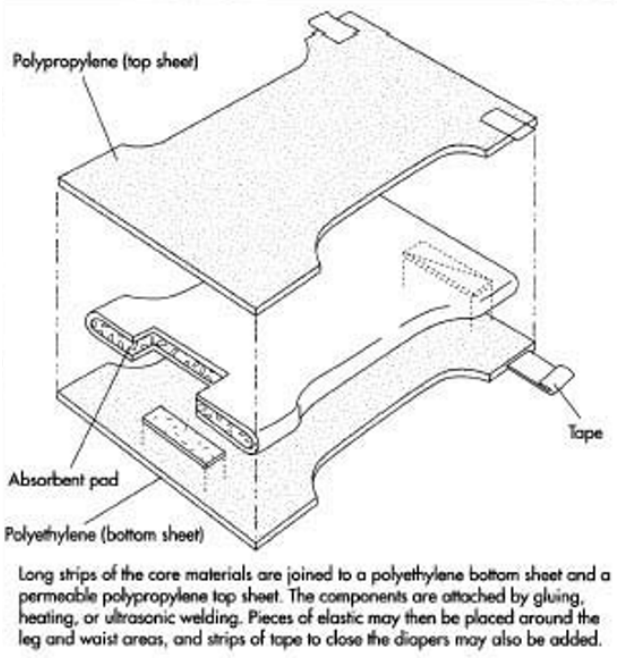
- Superabsorbents are useful not only for personal hygiene (diapers, adult incontinence pads, and so on) but also for mopping up medical wastes in hospitals, for protecting industrial power and optical cables from water leaks, for filtering water out of aviation fuel and for conditioning garden soil to hold water—not to mention as toys that expand when placed in water.
- A study published in 1999 found that mice who were exposed to disposable diapers suffered eye, nose and throat irritations, some resembling an asthma attack. Gases emanating from solvents and other chemicals in the diapers were suspected to be responsible. Superabsorbents were withdrawn from use in tampons after an outbreak of toxic shock syndrome in 1980.
- Babies in cloth diapers are toilet-trained almost a year earlier than babies in disposables. Although that could be a matter of cultural mores, it is probably also because the disposables are so absorbent that often neither baby nor caregiver can tell when the baby eliminates, and so the child can't easily associate the act with using the toilet.

LARGE DISPOSABLE DIAPER can hold half a gallon of water. Superabsorbents are the secret.

Baby Diapers, Disposable







Long strips of the core materials are joined to a polyethylene bottom sheet and a permeable polypropylene top sheet. The components are attached by gluing, heating, or ultrasonic welding. Pieces of elastic may then be placed around the leg and waist areas, and strips of tape to close the diapers may also be added.

Super Absorbent Polymer (SAP)

The secret sauce inside disposable diapers since the mid-80s has been SAP. These tiny crystals are sprinkled inside the layers of the absorbent core of a diaper to absorb and trap fluid (i.e., from urine and wet poopy). These crystals go by several names including hydrogel, sodium polyacrylate, polyacrylate absorbents, or in Pamper's FAQ as Absorbent Gel Material (AGM) and can absorb a significant amount of liquid given their smaller size. It's not just major brands like Pampers and Huggies using SAP; it is in ALL of the diapers we tested. And we mean all.

SAP is claimed to absorb up to 300x its weight in water and retain it. In the left photo you see a small pile of white SAP crystals from a diaper's absorbent core. It has a consistency of a very fine white sand. We then added 65 drops of water which was completely absorbed by the SAP in a few minutes to become the gelatinous crystal pile you see from two angles in the center and right photos.

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http://www.madehow.com/Volume-3/Disposable-Diaper.html
https://www.babygearlab.com/expert-advice/what-is-inside-those-disposable-diapers

Baby Wet Wipes

They are generally made from non-woven materials – usually fibrous materials like cellulose from wood pulp, sometimes reinforced with polymers like viscose. Non-flushable wipes may include man-made fibres like poly(ethylene) or poly(propylene) for extra strength.

The fibres are spun into a tangled mat and then compressed, along with binders and other materials, to make a sheet. This can then be impregnated with cleaning products, preservatives and other chemicals, depending on the intended application.

Flushable wipes generally use shorter fibres than non-flushables, and may include treatments to help them disintegrate more quickly after use.

https://www.chemistryworld.com/news/explainer-are-flushable-wet-wipes-really-flushable/1017594.article

Wet Wipes (Flushable?)

https://www.bbc.com/news/blogs-magazine-monitor-31969689

Laundry Detergent Eco Sheet

What are the ingredients of Earth Breeze Laundry Detergent Eco Sheets?
Our Laundry Detergent Eco sheets are simply formulated for a powerful clean.
Our formula is dermatologist tested, bleach-free, phosphate-free, phthalate-free, paraben-free, as well as vegan and cruelty-free!
All of our Laundry Detergent Eco Sheet ingredients are certified readily biodegradable by OECD 301B standards and do not contain microplastics.

Earth Breeze Laundry Detergent Eco Sheets are made from Glycerol, Primary Alcohol Ethoxylate, Sodium Dodecyl Sulfate, Sodium Acetate Trihydrate, Protease, Polyvinyl Alcohol (100% water soluble), Deionized Water, and Starch.
The Fresh Scent variant is made from Glycerol, Primary Alcohol Ethoxylate, Sodium Dodecyl Sulfate, Sodium Acetate Trihydrate, Protease, Polyvinyl alcohol (100% water soluble), Deionized Water, Fragrance, and Starch.

https://help.earthbreeze.com/laundry-eco-sheets-questions/what-are-the-ingredients-of-the-laundry-detergent-eco-sheets

https://tworoamingsouls.com/earth-breeze-review-best-eco-friendly-laundry-detergent-sheets/

https://www.tru.earth/?redirect=1&source=https://www.truearth.uk&country=United%20States

Self-Adherent Wrap

The standard 3M™ Coban™ Self-Adherent Wrap's cohesive strength is obtained from the natural rubber latex in the product composition.

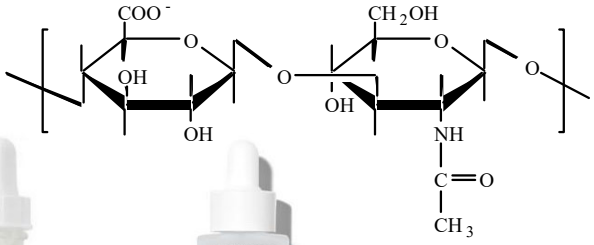
https://multimedia.3m.com/mws/media/82090O/common-questions-coban-self-adherent-wraps.pdf

Coating of nonwoven microfibers with the natural rubber latex

Absorbent self adhering elastic bandage, US5939339A
https://patents.google.com/patent/US5939339A/en

Cosmetics

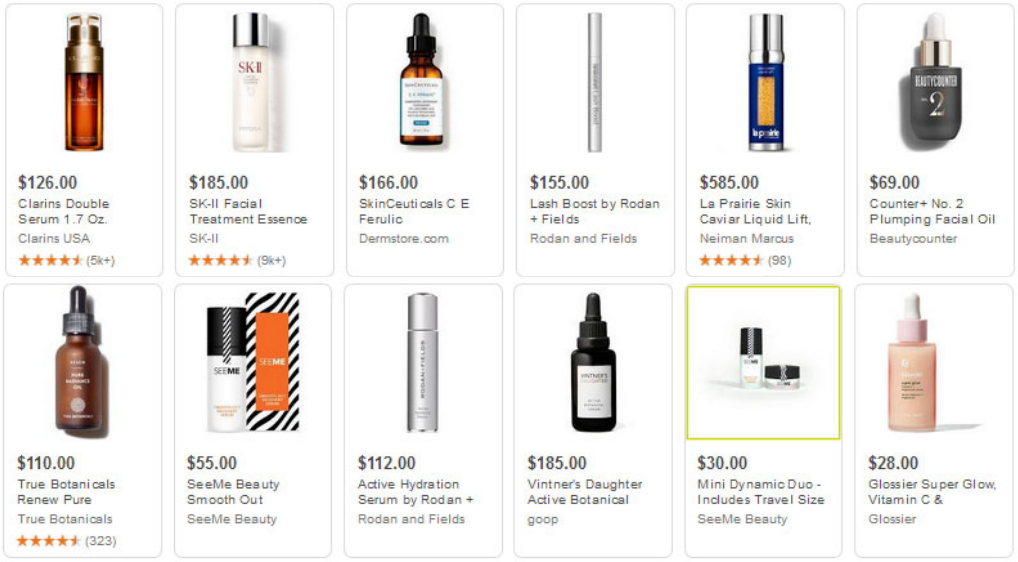
Hyaluronic acid



The Ordinary's Hyaluronic Acid 2% + B5, $6.80

Dr. Barbara Sturm's Hyaluronic Serum, $300

https://www.huffpost.com/entry/hyaluronic-acid-difference_l_5e138fdde4b0b2520d260b53?ncid=APPLENEWS00001



Cosmetic Serum is a highly concentrated product based on water or oil as any other cream. Serums, or concentrates, contain approximately ten times more of biologically active substances than creams, therefore quicker and more effectively coping with cosmetic problems.

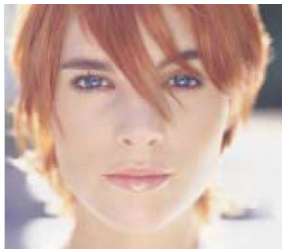
According to the effect produced all serums are strictly divided into the following categories: lifting up, revitalizing (rejuvenating and regenerating), moisturizing, nourishing, anti-inflammatory, soothing, and anti-stress.

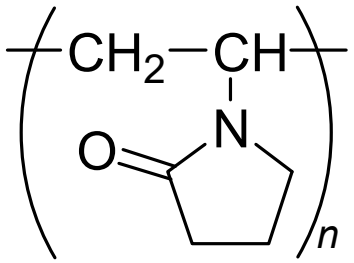
A product that fights skin dryness will only contain moisturizing components (plants extracts, hyaluronic acid, glycosaminoglycans). Rejuvenating concentrates may contain collagen, elastin, or placenta cell extracts (placenta cell extracts should not be confused with stem cells). Serums, that release inflammation, contain such components as witch-hazel and panthenol; those meant for blood circulation activation contain horse-chestnut extracts.

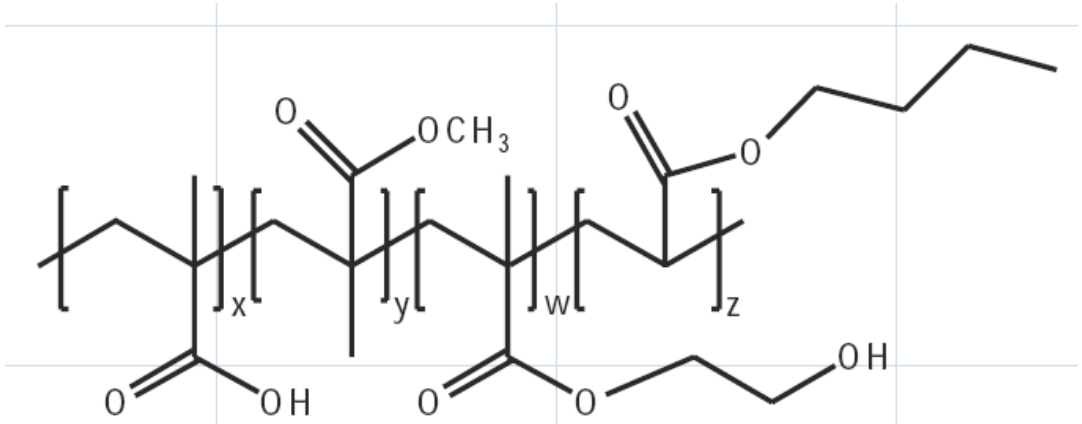
https://www.ost-cosmetics.com/about-skin-care/anti-aging-serum.html

Personal Care Products

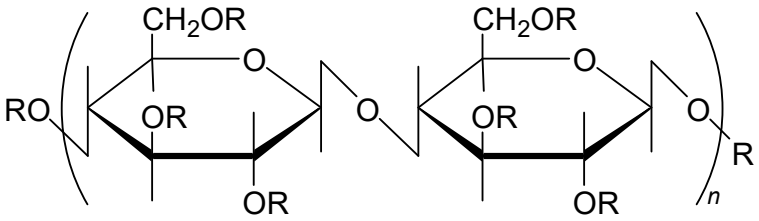
Hair Spray Application







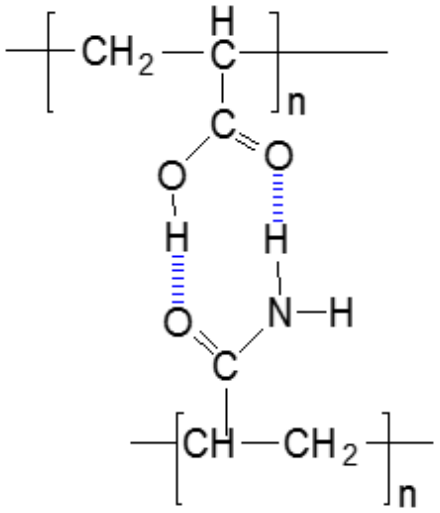
Acudyne 180 is a linear, random tetra polymer of methacrylic acid, hydroxyethyl methacrylate, methyl methacrylate and butyl acrylate. It is manufactured as an emulsion in water, with tight molecular weight control. In this form, it is easy and fast to formulate into liquids or gels.



R = H or CH_2CHCH_3 (OH)

Tooth-Whitening Kits

Poly(acrylic acid) in acid form



Intermolecular Hydrogen Bonding

Strong Adhesive

No charge
Poor water solubility

Tooth-Whitening Kits

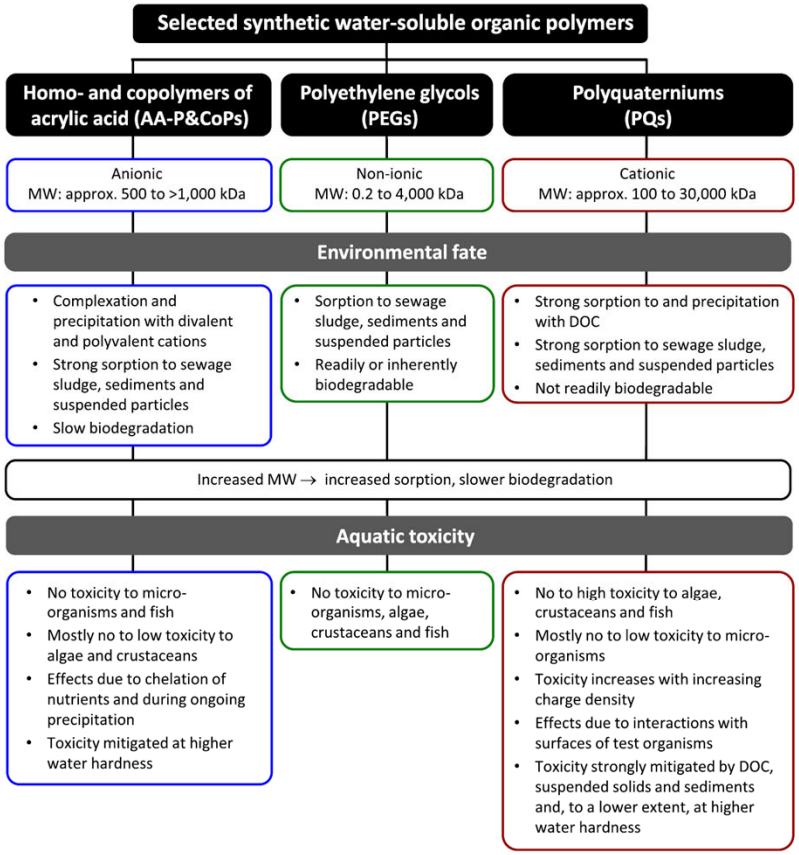


Fig. 1 Overview of the environmental fate and aquatic toxicity of the considered water-soluble synthetic polymers based on the evaluated data. Note that in the present evaluation, data for polymers with lower or higher MW than used in cosmetic products were also considered

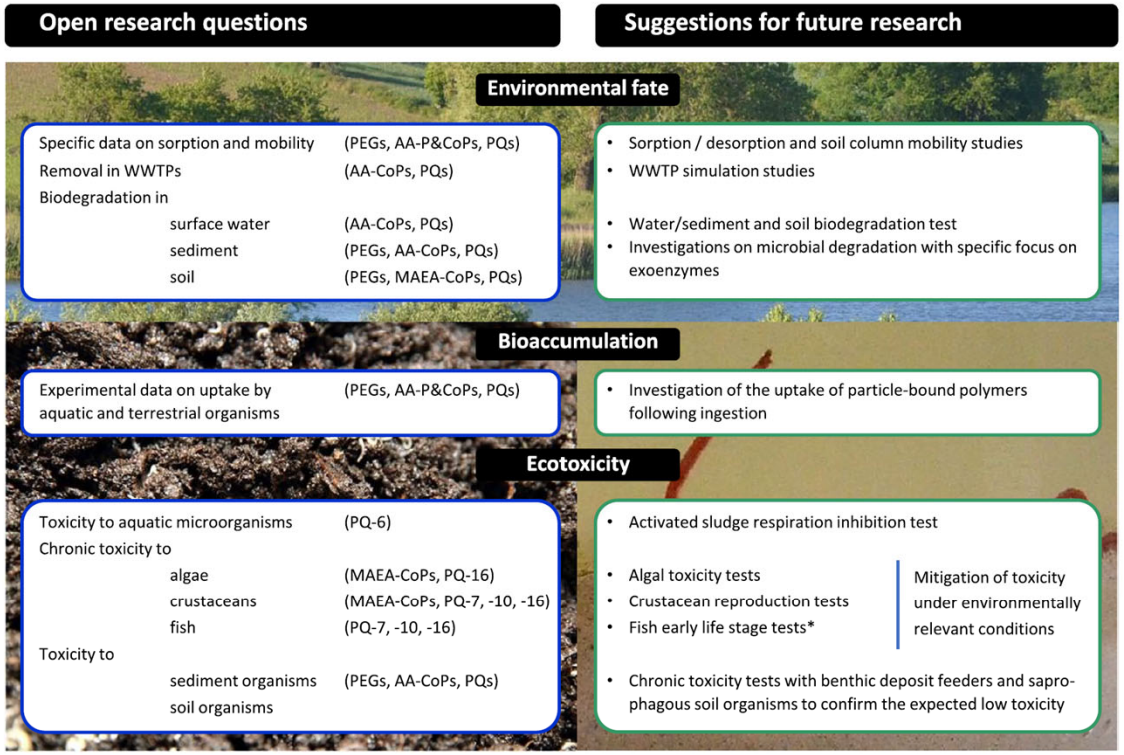
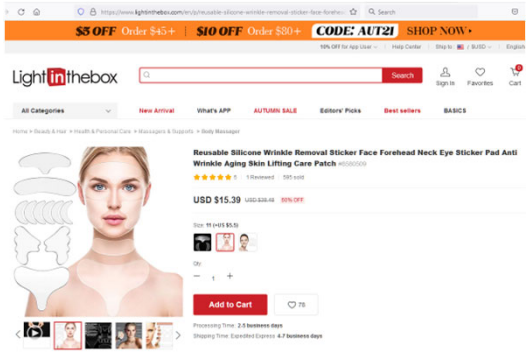


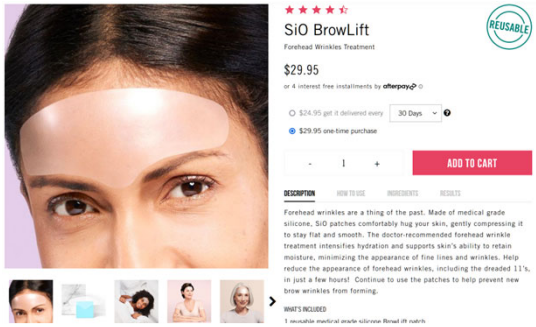
Fig. 2 Open research questions and suggestions for future research that were identified in the present review, which is mainly based on publicly available data. The polymers, for which the respective data were not available, are indicated in brackets. It is proposed to perform the suggested studies with representatives of the respective polymer class. *: Chronic fish tests (fish early life stage tests) are only recommended for polymers showing acute fish toxicity. They should only be performed after careful consideration of non-animal test methods, and if triggered in an environmental risk assessment

Duis 2021, Environmental fate and effects of water-soluble synthetic organic polymers used in cosmetic products

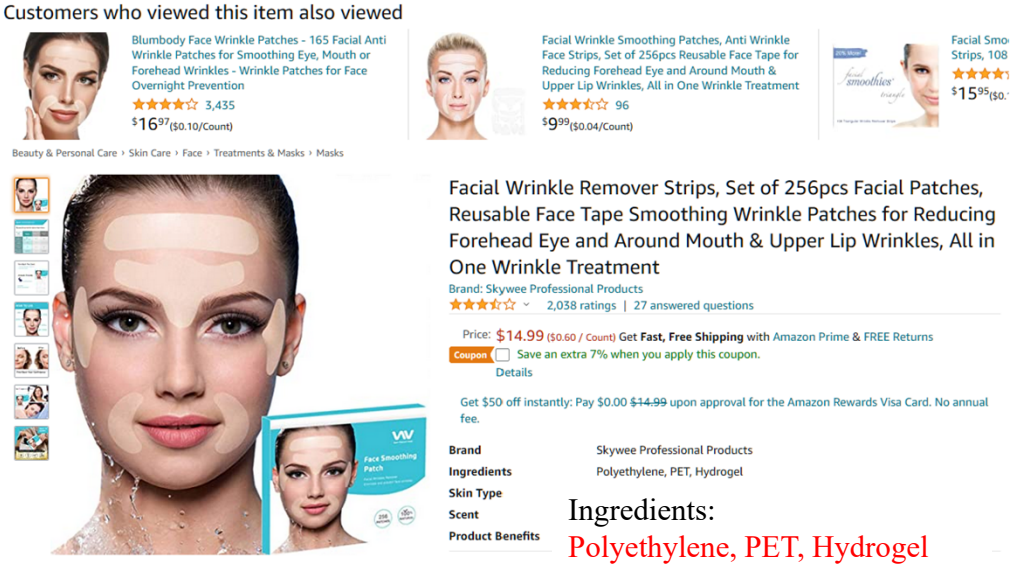
Polymers for Wrinkle Removal

Reusable Silicone Wrinkle Removal Sticker Face Forehead Neck Eye Sticker Pad Anti Wrinkle Aging Skin Lifting Care Patch





https://www.amazon.com/vdp/0ea895e1f4d04275bd635fbfe1b1d714?product=B07DXQR955&ref=cm_sw_em_r_ib_dt_ys2ECbefrjA9y



Ingredients:
Polyethylene, PET, Hydrogel

Ingredients:
Polyethylene Film,
Medical Acrylic Ester Polymer,
Ethyl Acetate

https://www.amazon.com/Facial-Patches-Wrinkle-Remover-Strips/dp/B07DXQR955

Beauty Products That Are Totally Genius

2. These Under-Eye Shields That Catch Eyeshadow Fallout

TailaiMei Professional Eyeshadow Shields for Eye Makeup (120-Pieces)

Amazon

$7 See On Amazon

6. These Double-Sided Exfoliating Brushes For Your Lips

YOUKOOL Double-Sided Silicone Exfoliating Lip Brush (2-Pack)

Amazon

$6 See On Amazon

Exfoliating your lips will accomplish two things: It'll make your lipstick glide on more smoothly and evenly, and it'll also make your lipstick look better since there won't be any visible flakes. While lip scrubs are great for this, lip brushes are even better, since they eliminate any messiness associated with the process. With this order, you'll get two double-sided lip brushes, both made of hygienic silicone.

12. These Silicone Mask Covers That Prevent Your Sheet Masks From Slipping

Lindo Silimask Reusable Silicone Face Mask Holder

Amazon

$11 See On Amazon

Everyone loves a good sheet mask, but it's admittedly annoying that you can't go about your business while you're wearing one, lest it slip off. So here's a genius solution: These silicone mask covers that hold your sheet mask in place so you can watch TV, walk around the house, and cook a batch of pasta all while you pamper your skin. You'll get two mask covers with each order, both made of easy-to-clean silicone.

14. 96 Pimple Patches From A Cult Korean Brand — For Under $15

COSRX Acne Pimple Patches (96-count)

Amazon

$14 See On Amazon

The OG genius beauty product, COSRX's pimple patches are a longtime cult-favorite among skin care obsessives. They help heal your blemishes faster, prevent you from picking at them, and keep away outside bacteria, and they're totally translucent and discreet. In each pack, you'll get 24 patches in three sizes, and since this order comes with four packs, that's *96 patches* for less than $15.

24. These Silicone Brushes To Massage Your Scalp In (Or Out Of) The Shower

Cbiumpro Scalp Exfoliator (2-Pack)

Amazon

$7 See On Amazon

You can use these funky-looking silicone brushes to massage your scalp with or without shampoo, in or out of the shower — both methods feel equally amazing. Sold in a pack of two, they're great for when you've been wearing your hair in a tight ponytail or bun, but they can also be helpful for relieving dandruff symptoms, like flaking and itching. Impressively, they've been awarded over 25,000 five-star ratings by Amazon shoppers so far.

25. A Heat-Resistant Mat To Safely Lay Down Your Hair Tools

EIOKIT Silicone Heat Resistant Travel Mat

Amazon

$7 See On Amazon

The perfect example of a simple but genius product, this silicone mat can be used two ways: First, you can lay your hot hair tools on it when you're using them to prevent your countertop from being burned, and second, you can slip your most-used hair tool inside and use the mat as a protective case when you're traveling. Over 4,000 Amazons shoppers gave this seemingly-simple product a perfect five-star rating.

41. These Hot Or Cold Eye Masks That Feel Amazing On Tired, Puffy Eyes

Optix 55 Gel Eye Mask Hot Cold Compress

Amazon

$10 See On Amazon

This bead-filled mask can be used hot or cold to depuff skin, soothe dry, itchy eyes, and ease sinus infections, allergies, and headaches. It's latex-free and safe for sensitive skin, and offers a gentle alternative for those who can't use topical products to accomplish any of the aforementioned goals. Just keep it in the freezer for a cooling anytime treat, or pop it in the microwave to warm it up.

https://www.bustle.com/style/amazon-keeps-selling-out-of-thesebeauty-products-that-are-totally-genius

Microfiber Towels

Microfiber is any synthetic fabric created from threads with a diameter of one decitex or less – the unit of linear density of a continuous filament or thread. (Except in the US, where the French term denieris still used. One decitex is 1/10th of a denier, pronounced deh-NEER). To put that into context, the average microfiber filament is 10 micrometers in diameter. That's a tenth of the width of a strand of silk and a fifth of the width of human hair. In other words, it's really, really fine.

Due to the diameter of the threads, microfiber attains several characteristics which even the finest cotton and silk threads can't ever hope to achieve. It's lightweight, wrinkle-resistant, super durable, non-electrostatic, hypoallergenic, washable, dry-cleanable, shrink-proof, and it retains its shape even after it's been stretched. When used in clothing, it also drapes beautifully while retaining its ultra-soft texture.

A Brief History of Microfiber

Microfiber is something of a wonder material which was first created in Japan in the late 1950s. In line with true Japanese efficiency, scientists were looking for a "micro-denier" product which could quickly get machine parts cleaner, absorbing all manner of liquids without leaving lint or debris which could interfere with operation. In the process, they created Ultrasuede, a material which became popular in Japan as a fashion trend, for furniture, automobile interiors, and as a protective fabric for electronics.

However, it wasn't until Sweden popularized it as a household product in the 1990s that microfiber really caught the public's eye. After experiencing wild success in Europe for another decade, it eventually made its way to the US in the early 2000s where its uses expanded even further. One of those uses included hair care. In 2006, Turbie Twist became one of the first brands of microfiber hair towels on the market. The hair drying revolution had begun.

Microfiber: The Day Science Created Perfection

Officially, any fabric measuring one decitex or less qualifies as microfiber. In practice, most microfiber is synthetic because it's exceedingly difficult to create cotton, silk or wool threads at that diameter. The most common microfiber materials include:

Acrylic, Nylon, Polyester, Polyester with polyamide, Polypropylene, Viscose, Any of the above mixed with natural fibers,

Our microfiber Turbie Twist® hair towels use a polyester-polyamide blend. Polyamide is a naturally occurring protein which gives wool and silk its natural strength. When mixed with polyester, it conveys the strength, durability, and slight elasticity which allow our hair towels to hug your head without smashing your hair.

16. These Microfiber Hair Towels With Tons Of Benefits

YoulerTex Microfiber Hair Towel Wrap (2-Pack)

Amazon

$4 See On Amazon

Instead of using a big, heavy towel to dry your hair after showering, invest in these lightweight microfiber towels instead. Not only are they a lot more comfortable to wear, but because microfiber is super absorbent, these towels can help your hair dry faster, too. They stay securely affixed onto your head with a button and loop, and come with two towels per pack.

22. These Gentle Cloths That Can Remove Makeup With Just Water

S&T INC. Always Off Reusable Makeup Remover Cloths (5-Pack)

Amazon

$8 See On Amazon

These microfiber cloths are capable of removing makeup with just water, but you can also use them with your micellar water or cleanser of choice to give your skin a more thorough clean. Skeptical? Then just listen to the 10,000-plus Amazon shoppers who left them a five-star rating or review. One person wrote, "I was skeptical of these, but now I'm pretty sure they're what Mulan's outfit was made of when she wiped her makeup off on her sleeve in the movie. Even totally dry they're pretty impressive about taking all of my makeup (including waterproof eyeliner and mascara) in a couple swipes. I like to use a little micellar water to make my skin feel a little cleaner. It's nice not to burn through so many cotton pads."

Split vs. Whole Fibers

Finally, it's worth noting that not all microfiber is created equal. Since it's synthetic, microfibers tend to be customized for its intended purpose much more than other types of fabrics. That's why you can find microfibers made from so many different materials. There are actually twelve different spinning methods to create microfiber fabrics, but we're concerned about the one type in particular: split type spinning, as compared to whole fiber spinning (typically the other eleven types).

In split type spinning, the fibers are first split into so that if you looked at the end of one of the threads under a microscope, you'd see a star-shaped pattern. This dramatically increases the amount of surface available over each individual thread. It's what allows microfiber cleaning clothes to catch so much dust while leaving nothing behind. However, splitting the thread also breaks the protein wall of each thread, inducing the hyper-absorbency associated with microfiber – the very feature which makes it so excellent for drying your hair quickly. It's easy to test if a microfiber was created through split type spinning or another method. Simply dip a corner in some water. If it seems to repel water, then you're dealing with a whole fiber. If it wicks it up rapidly, then congratulations. You've got split type spun microfiber.

Why Choose Microfiber to Dry Your Hair

Now that we've covered exactly what microfiber is and how it's made, it's easy to see what makes it so great for drying your hair. Microfiber: Is extremely gentle on your hair. It's soft, frictionless, and has enough elasticity that it won't damage your lovely locks. Costs much less than high thread-count cotton. Genuine cotton is expensive because it needs to be spun in a specific way to achieve the thread count necessary to match microfiber's smoothness. It's so absorbent it will dry your hair faster than other methods. Thanks to the split fibers, microfiber is one of the most efficient ways to dry your hair.

https://www.turbietwist.com/blogs/hair-towels-101/everything-you-need-to-know-about-microfiber

Anti-Blister Spray

PreHeels + Bilster Prevention Spray

Perfect to use with pesky heels, sandals, sneakers and more.
All you have to do is apply the formula to clean, dry skin (about four inches away) where rubbing normally occurs, then allow it to dry for approximately 90 seconds before wearing footwear. I used this spray prior to slipping on some brand new mules for an NYC evening out, and between bar hopping and walking to and from subways, I didn't incur a single blister even in 85-degree weather.

Its key ingredients are friction-blocking particles (also used in nail polishes) that bond together to form a strong, breathable barrier on skin; a synthetic, cosmetic-grade polymer for a flexible finish; and a smoothing agent often found in many deodorants and face creams to create a soft feel. Other ingredients include an eco-friendly propellant that allows the spray to be applied evenly and SD alcohol, which although known to be somewhat drying in skincare products, does prevent the consistency from being overly thick and bulky. All in all, PreHeels+ is hypoallergenic and dermatologist-tested to be safe for use on all skin types. Plus, it's vegan and cruelty-free.

https://www.prevention.com/health/a40708470/preheels-blister-prevention-spray-review/

Ingredients

Dimethyl Ether, SD Alcohol, Acrylates Copolymer, (Purified Cosmetic-Grade) PEG-8 (=PEG 400), Dimethicone Copolyol Blend

https://www.amazon.com/dp/B07N15HKWN?linkCode=ogi&tag=prevention-auto-20&ascsubtag=%5Bartid%7C2141.a.40708470%5Bsrc%7C%5Bch%7C%5Blt%7C

Polymers in Protection

Ultra High Molecular Weight Polyethylene & Rubber

Panama Canal Installs Marine Fendering System From Solidur Plastics

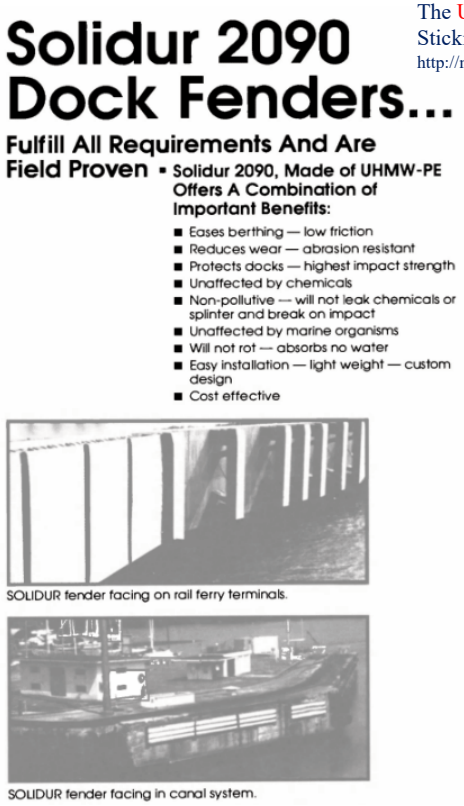
https://www.marineinsight.com/guidelines/how-the-water-locks-of-panama-canal-work/

A ship leans against the fenders a little bit while the water is going up or down in the chamber to protection of both the vessel and the lock.

Solidur Plastics Co., Delmont, Pa., supplied an Ultra-High Molecular Weight Polyethylene (UHMWPE) marine fender system for the locks at the Panama Canal to protect oceangoing ships from the damaging impacts of bumping into the lockwalls.

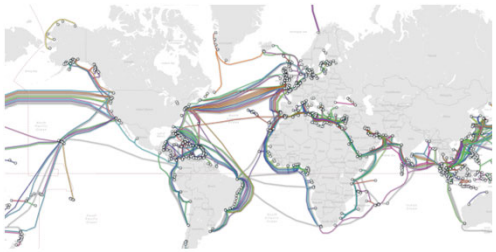
An incoming ship moving through the locks under its own power is assisted by locomotives which help the ship steer into the lock chamber. With some clearances between lockwall and hull as little as 1-1/2 feet, rubbing against the fenders is unavoidable.

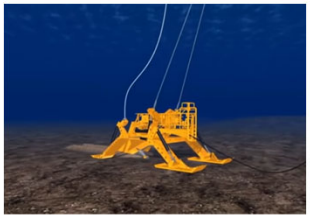
The UHMW-PE block sandwich provides a low-friction surface that allows the vessel to slip by the fenders. Sticking or gouging usually incurred by less effective systems is eliminated.
http://magazines.marinelink.com/Magazines/MaritimeReporter/199103/content/installs-fendering-plastics-200226

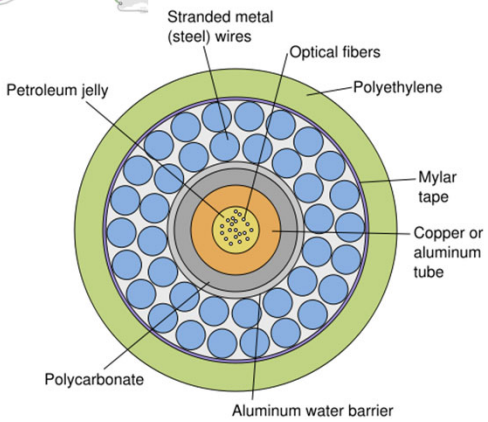


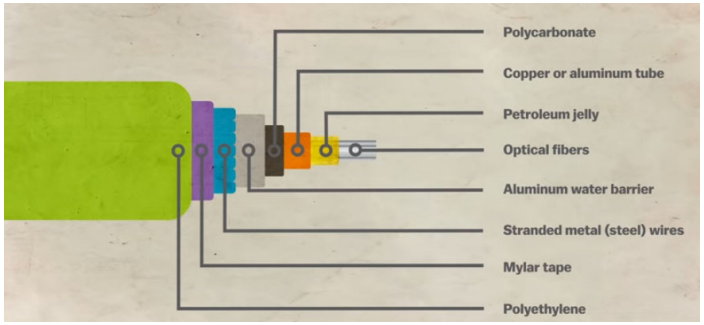
http://magazines.marinelink.com/Magazines/MaritimeReporter/199102/flash/?page=44

Internet Cable Across the Ocean



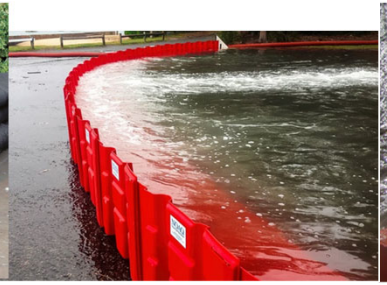






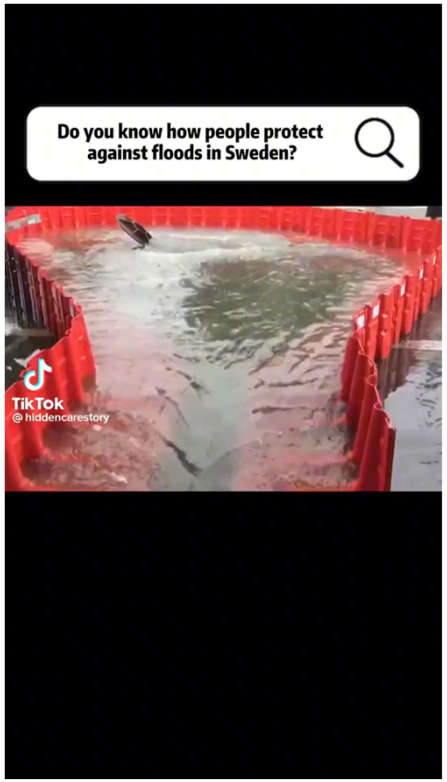
https://www.tigs.in/underwater-vulnerability/
https://www.businessinsider.com/map-shows-extent-of-undersea-internet-cables-that-russians-could-cut-2017-12
https://www.weforum.org/agenda/2016/01/how-does-the-internet-cross-the-ocean/
https://thekidshouldseethis.com/post/thin-underwater-cables-hold-the-internet-vox

Protection Against Flood



The Swedish Noaq company was created for the purpose of developing and selling flood protection systems throughout the world. Working in collaboration with Swedish rescue services, it developed the “Boxwall” which is a thermoplastic, modulable, self-stabilising and mobile flood protection device which can be set extremely quickly. It is made up of identical section forming tubular barriers that fit together in an “L” shape. The system has been patented in many countries.

Both ultra-lightweight and self-stabilising?
The barriers are made up of reinforced PVC fabric tubes inflated with air, connected at each end using ordinary zippers. An apron is welded each to hit, and it lies on the ground on the “flood side”. When the water rises above the apron, the weight of the water pushes the apron against the ground and so anchors the tube.
The barriers are made waterproof thanks to foam seals under the edge of each section. In order to ensure that they grip the ground, each section has an expanded rubber base.
Each barrier weigh less than 1-2% of the weight of sandbags, and only requires 2 to 4 people to place it. 2 people can set up 100 m of barriers in just 50 minutes.

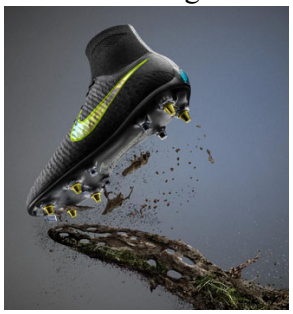


https://noaq.com/en/home/
https://plastics-themag.com/Flood-barriers

Polymers in Shoes

HyperAdapt Self-tying Shoes

Nike Anti-Clog Traction: a mud-beating polymer



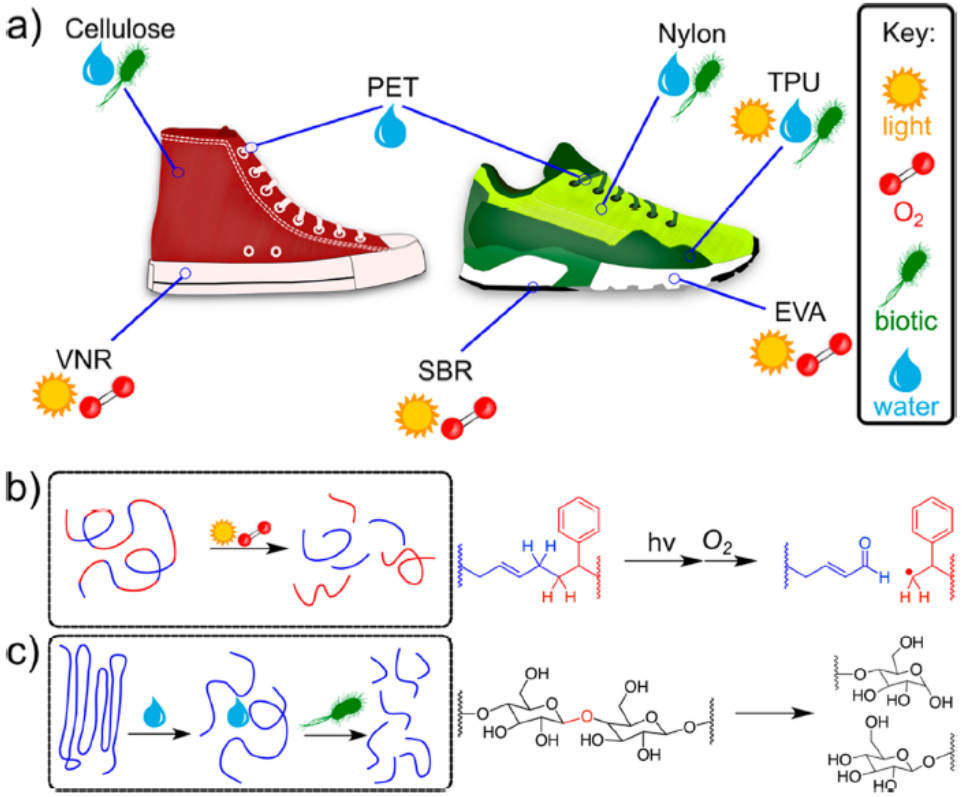
http://news.nike.com/news/anti-clog

Nike HyperAdapt Self-tying Shoe

Years of trial and error lead her to create a shoe equipped with a pressure sensor, rechargeable lithium-polymer battery, lightweight micromotor, and cable system to adjust the fit as the wearer puts it on. The tongue of the shoe appears to have laces, but they serve more as a visual indication of how tight or loose they are to the wearer. The fit of the shoe is actually controlled by a cable system that is woven into the polyester mesh of the shoe's upper.

https://www.wired.com/2016/09/nike-self-lacing-design-hyperadapt/
http://www.csmonitor.com/Technology/2016/0921/How-do-Nike-s-self-lacing-sneakers-work-video

Shoes Made of Sustainable Polymers



Schneideerman 2017, There is a great future in sustainable polymers

Carbon Fiber Snowshoes

These Carbon Fiber Snowshoes Can Elevate Bulky Winter Footwear
Komperdell's Air Frames are the featherweight way to scale those winter hills.
By Ami Kealoha. January 14, 2020. Bloomberg Businessweek

The Carbon Air Frames weigh just 639 grams, or 1.4 pounds.
Photographer: Jessica Pettway for Bloomberg Businessweek

Wooden Snowshoes. Weight: 6.5 lb. per pair.
https://www.llbean.com/llb/shop/114016?feat=509581-plalander&csp=f&gnrefine=1*Color/Style*Wood

For millennia, snowshoes have been adapted to fit the terrain and the people who use them. Consider these $350 Carbon Air Frames, from Komperdell Sportartikel GmbH, the peak option for our time. Carbon fiber construction—first used in the Austria-based company's ski poles—replaces aluminum to streamline winter's bulkiest footwear to 639 grams, or 1.4 pounds. That makes them the lightest pair on the market. The frame and the decking, usually separate, are here combined to form a cohesive one-piece unit that's 25 inches long and rated to support 220 pounds.

THE COMPETITION

- Crescent Moon Snowshoes Inc. makes its 3.5-pound Evas ($159) out of foam for a flexible experience that's almost as comfortable as wearing sneakers.
- A favorite among outdoors enthusiasts, MSR's $220 Lightning Trails feature nylon decking with an aluminum frame. The shoes, which weigh a little more than 3 pounds each, also come in a version specifically designed for women.
- If you want to trade weight for durability, the Fimbulvetr Tankr X snowshoes ($319) are extra-long at 38 inches and made of a stiff compound material with stainless-steel crampons for a total weight of 7 pounds.

THE CASE

A full 50% lighter than average snowshoes, the Air Frames are next-level powder gear. Their step-in bindings are designed for all types of footwear, and a "live-action hinge" will put a literal spring in your step. A two-point toe crampon and side rail teeth are also integrated, but they're not meant for walking on hard, rocky terrain. Think of them more as the ultimate in snow-trekking pleasure—they're suited for most skill levels, terrain, and conditions. Mundane winter tasks aren't immune from their charms, either: Strap them on for an adventurous walk with the dog, or, if you drive a lot on snowy roads, store them in the trunk of your car next to your flare and your spare. $350

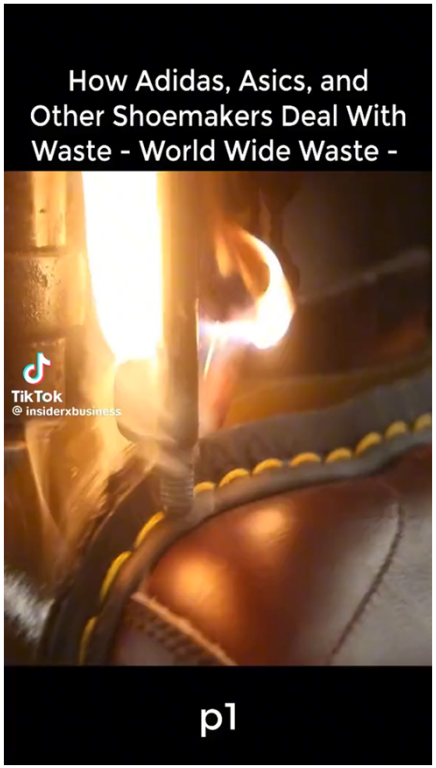
A Greener Running Shoe

The Best Inventions of 2020: A Greener Running Shoe, Allbirds Tree Dasher

Jessica Pettway for TIME; Prop styling by Stephanie L. Yeh

Running shoes are incredibly wasteful, relying heavily on oil-based synthetics like plastic. The Allbirds Tree Dasher is made almost entirely from natural materials, with a carbon footprint estimated at almost a third lower than that of the average sneaker. But using **eucalyptus, merino wool, castor-bean oil and sugarcane** isn't just about "stuffing nature into a performance shoe and hoping that it doesn't degrade the performance," says Jad Finck, Allbirds' vice president of innovation and sustainability. Instead, these materials actually boost performance: the eucalyptus fibers are cooling, the wool regulates temperature, and the sugarcane midsole provides performance cushioning. And while the Tree Dasher is not meant for marathons, the shoes— priced at $125—are well suited for a weekend jog or a morning dash to the grocery store. —Sanya Mansoor

Allbirds Men's Tree Dasher, Allbirds Women's Tree Dasher
November 19, 2020



Polymers in Sports

Life-Saving Crash Helmets

Shock-absorbing science
A layered crash helmet reduces the impact of an accident. How headgear limits injuries and saves lives during small falls and serious crashes

2 IMPACT-ABSORBING LAYER
Expanded polystyrene foam lines the outer shell. When the helmet is hit, the foam absorbs much of the impact energy.

3 SOFT PADDING
Cushioning foam and soft fabric are in direct contact with the rider's head. This provides comfort and keeps sweat off the face.

5 CHIN STRAP
This fastens under the chin, helps hold the helmet in place and keeps the head protected even when a crash knocks the driver from an upright position.

1 OUTER SHELL
This layer is first to be impacted. It's usually made of hard polycarbonate plastic or synthetic fibres such as kevlar or carbon fibre.

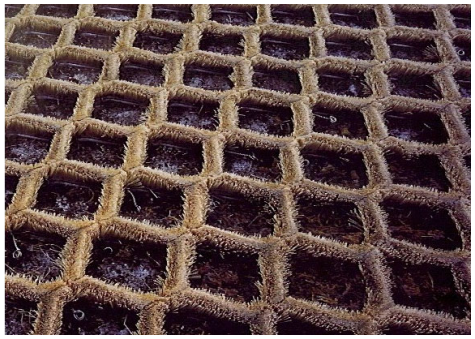
6 VISOR
An eye and face shield stops debris from entering the helmet and helps drivers keep their eyes open and focused on the road.

7 MOUTHPIECE
A vent near the mouth stops the driver's breath from fogging up the helmet.

4 CHEEK PADDING
For extra comfort, and to hold the helmet in place, cheek pads press against the sides of the face.

Alisa Harvey, How It Works, Issue 171

Polymers Skiing, Snowboarding, and Ice

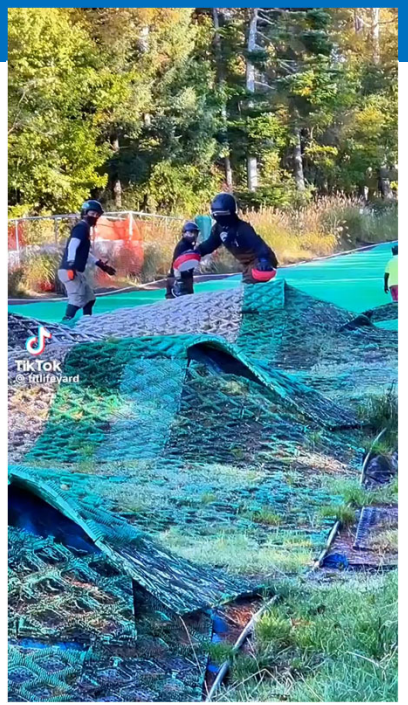


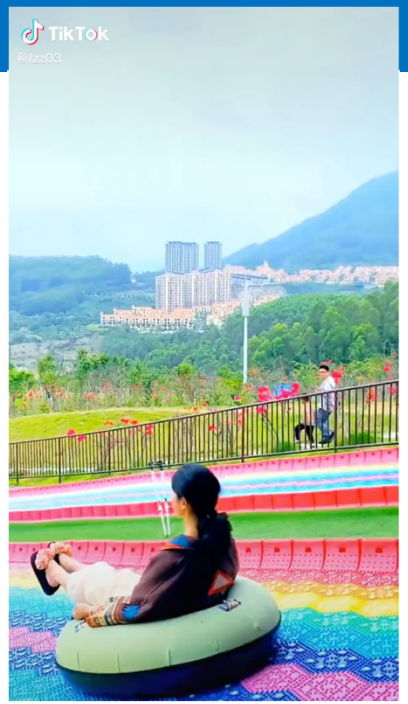
What are the different materials used on synthetic slopes?

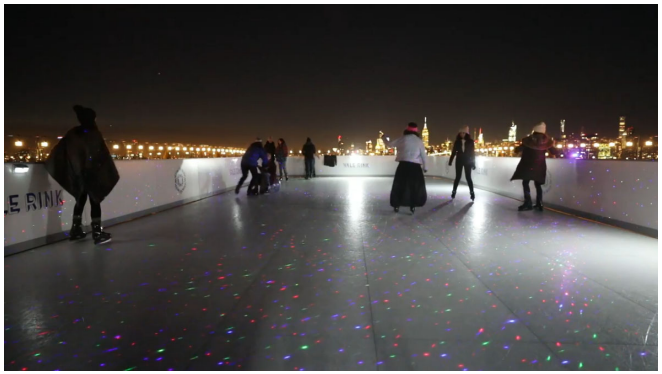
Nearly all synthetic ski surfaces that are available today are based on the same basic idea: The skier or snowboarder slides across thousands of little plastic bristles that respond in a way that is similar to natural snow. However, they differ significantly in design details, which has a big impact on the skiing experience.

1. Dendix is a PVC-based brush arranged in a honeycomb tile, and was the first widely deployed ski surface. Its design dates back to 1961, and for a long time it was the only game in town. It has a reputation as a great surface for racing but not much else, which is not surprising as in our experience it seems to operate in two modes: either you are sliding across the top or you are on a hard edge with little in-between. Takes a lot of getting used to.
https://www.urbansnow.ski/blog/all-about-synthetic-dry-slopes

Powder Ridge's dry slope of choice, a series of synthetic ski mats with plastic polymer "fingers" sticking up above the surface, is sourced from Swiss company 365, beating out other dry slope materials such as Neveplast (Buck Hill) and Snowflex (Liberty). With ski resorts increasingly looking to capture four-season business, and with higher temperatures shortening ski seasons, synthetic-snow systems look to be a growing slice of the ski industry. (https://www.skimag.com/ski-resort-life/no-snow-no-worries-at-powder-ridge)

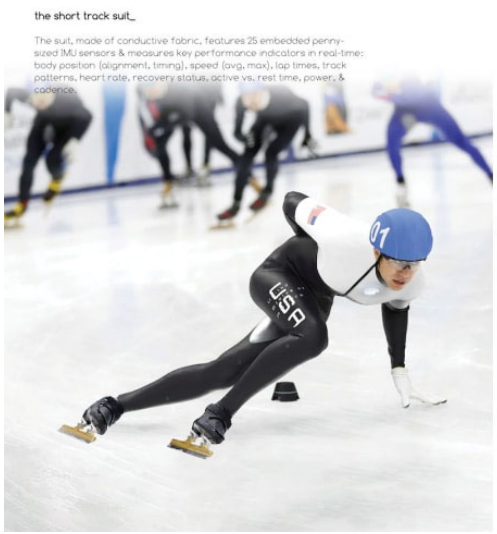






https://www.nytimes.com/2020/02/01/business/glice-fake-ice-skating-.html

Kevlar in Short Track Skating



IOTA is a training tool designed to give elite level speed skaters real-time, comprehensive feedback during on-ice training. It provides an unprecedented level of analysis not only to coaches but also directly to athletes. The system comprises a suit outfitted with 26 embedded IMU sensors that record and analyze performance in real-time and communicate this data through digestible graphics via the accompanying app. In addition to visual feedback, athletes have the option to get real-time auditory feedback via an earbud. IOTA captures body position, speed, lap times, heart rate, track patterns, and blood pressure and uses algorithms to determine each athlete's optimum in these categories.

IOTA is unlike any other training tool in that it provides comprehensive performance data that has traditionally been impossible to capture outside of expensive lab settings. Currently, athletes are completely dependent upon coaches for feedback, and that feedback is neither individualized nor consistent. This is because it's extremely difficult to get cameras on the ice safely and time consuming to do video analysis during practice; coaches can't give each athlete consistent, customized feedback when working with large groups; and it's difficult for athletes to understand feedback without visuals to reinforce it. IOTA captures massive amounts of training data for each athlete and analyzes it in a digestible way, providing a complete picture of their performances.

This system was designed to require no significant changes in behavior from coaches or athletes; it integrates seamlessly into already established on-ice training practices.

IOTA isn't marketed to the masses and therefore doesn't need to conform to general consumer price points. Collegiate, World Cup, and Olympic teams would purchase this system as an investment into their athletes/teams, so cost is not as much of a limiting factor in terms of design and manufacture. Electronic components would be produced with the same practices and at similar price points used by companies like Apple and Samsung. Injection molded plastics and standard electronic parts would be used. The suits would be made of 3D knitted conductive fabric with integrated Kevlar. The sensors would be inserted once the body of the suit has been finished and then sealed in with a final stitch on the inside of the garment.

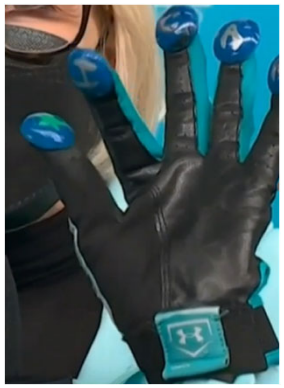
IOTA is designed for elite skaters, however, a takedown version of this system could be adapted for the semi-pro and amateur levels. Especially in countries where speed skating is popular like South Korea, China, Canada, and the Netherlands, the market for IOTA is present, and with speed skating becoming an increasingly global sport, the demand for an edge on the competition is growing quickly.

IOTA could also be adapted to other sports that have proven similarly difficult to gather comprehensive and accurate training data for like skiing, snowboarding, and swimming. Any sport would benefit immensely from the quantity and quality of data captured using IOTA. This system democratizes the highest quality augmented feedback technologies that can help every athlete get closer to their individual optimum.

https://contest.techbriefs.com/2020/entries/electronics-sensors-iot/10154

Short Track Skating

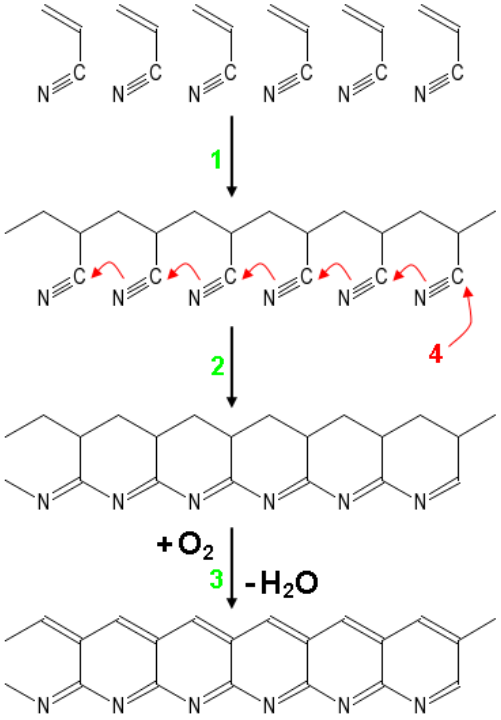
Carbon Fiber Tips



Cut-resistant Kevlar Short Track Speed Skating Suit

Carbon Fiber from Petroleum

1958



Polyacrylonitrile (PAN)

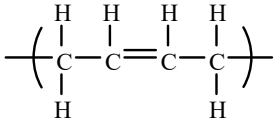
(1) Polymerization of acrylonitrile to PAN
(2) Cyclization during low temperature process
(3) High temperature oxidative treatment of carbonization (hydrogen is removed)
(4) Process of graphitization: nitrogen is removed and chains are joined into graphite planes

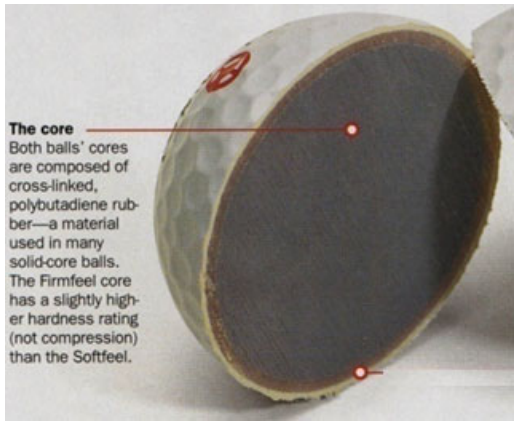
(http://en.wikipedia.org/wiki/Carbon_%28fiber%29)

A race car with a carbon fiber body. Rhots

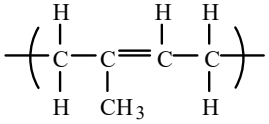
Golf

Polybutadiene (Synthetic Rubber)





Polyisoprene (Natural Rubber)



The skin controls spin and feel, and the core converts impact energy to kinetic energy.

WHAT IS INSIDE A GOLF BALL?
Original feathery ball from 1600-1800s
Tiny goose and duck feathers
Rubber Haskell ball circa 1898-1970s
Brown wound rubber
Spalding ball from 1967
Solid rubber core, inside a low spin surlyn cover
Nike Rzn White
Resin Polymer inner core
Srixon Q-Star
Surlyn cover with molecular covering to increase friction

WHAT IS INSIDE A GOLF BALL?
Wilson Duo
Soft rubber elements to enhance durability
Calaway Speed Regime 1
Dual rubber core with thermoplastic urethane cover
Bridgestone Tour 330 Series
Water-infused Polybutadiene rubber
Titleist NXT Tours
Polymer blend cover with a low compression core
Taylormade Tour Preferred X
3 ionomer mantles with a cast urethane cover

The different cores inside the balls affect how quickly it spins and how far it can fly.

There are strict rules on how golf balls are made, set by the R&A, based at the world's oldest golf club in St Andrews, Scotland, and they must not be heavier than 1.62 oz.

The dough, usually made from about a dozen raw ingredients, is colour-coded depending on its intended effects on a golfer's game.

https://www.dailymail.co.uk/sport/article-3150969/What-inside-golf-ball-Ten-sliced-open-solve-mystery-results-quite-surprising.html
https://www.dailymail.co.uk/sport/golf/article-2373776/Golf-balls-cut-half-Inside-look.html

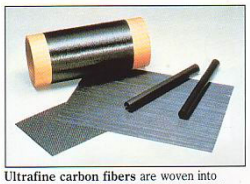
Tennis Racquets

How Are Carbon Fibers Used?

Carbon fiber is thinner than ordinary cotton thread but three times as strong as steel. It is made by heating an organic polymer yarn, such as rayon, pitch, or other polymers—materials with very large, long, cross-linked molecules—in ovens at about 2,500° C., or 4,500° F. This drives out atoms of other substances such as hydrogen and oxygen and allows carbon atoms to link together into a more involved crystalline structure. The resulting fibers are at once extremely strong and exceptionally elastic.

By themselves, however, carbon fibers are hard to manipulate. To further strengthen the fibers and make them easier to mold, manufacturers bond them with an epoxy resin, a plastic glue that hardens as it cures. Injected into a hollow mold, the plasticized fibers are left to harden.

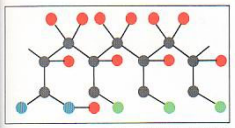
Most carbon fibers are used in plastic composites to make sporting goods such as tennis rackets, golf clubs, and fishing poles, as well as boat hulls, racing-car and aerospace components. Since these materials can be injection-molded into complex, precise shapes in one step, they are cheaper to use than metals. A composite part is also sturdier than metal, which must be bent, joined, and welded to form the same shape.



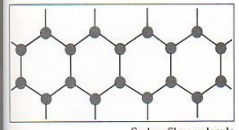
Ultrafine carbon fibers are woven into tough, heat-resistant fabrics or bonded with epoxy resins to create strong structural elements to be used in jets, rockets, and high-performance racing cars, and also for a great variety of sporting goods.

Stronger than steel and titanium and more flexible than metals or reinforced plastics, carbon fibers can stand up to a million pounds of pressure per square inch.

Versatile carbon fibers



Polymer molecule



Carbon fiber molecule

Chains of steely molecules

Some polymer fibers have a molecular structure that is netlike but has some loose ends *(left)*. Baking eliminates some elements, and the atoms rearrange into a net of strong hexagons *(bottom left)* with no loose ends.

Hydrogen
Carbon
Oxygen
Nitrogen

Only about one-seventh as thick as a human hair, carbon fibers are bundled into springy yarns containing 1,000 to 500,000 filaments. For many uses, such as this tennis racket, a plastic finish is added to improve stiffness and strength.

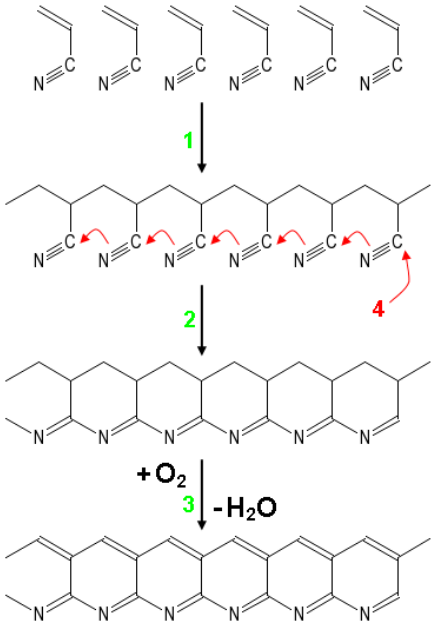
Tennis rackets are made of carbon fibers.

Satellite struts contain carbon fibers.

Space-age materials

Satellites sent into space must be lightweight but strong enough to take the strains of a launch. Many of the parts of a satellite *(above)* are made of metals and plastics reinforced with carbon fiber, because they are light, strong, and resistant to heat.

Carbon Fiber



Polyacrylonitrile (PAN)

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(http://en.wikipedia.org/wiki/Carbon_%28fiber%29)

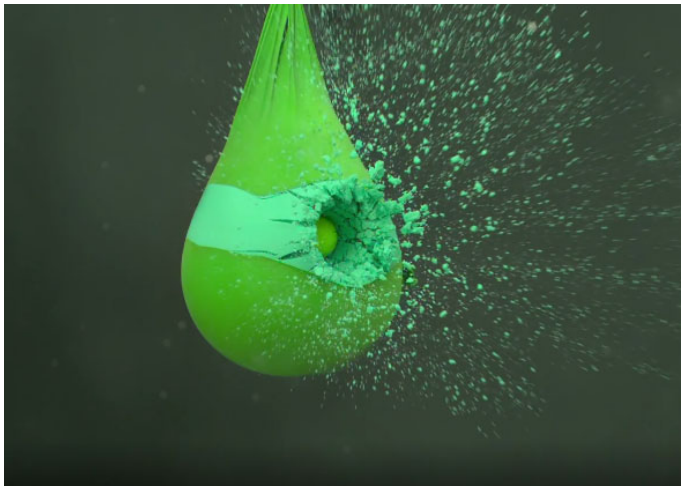
Polymer with Non-Newtonian Shear-Thickening Colloid Behavior

Oobleck & Ketchup

https://www.youtube.com/watch?v=ipDO2q7kRmg

Oobleck & Ketchup

Oobleck: Starch:Water = 2:1. Shear thickening properties.

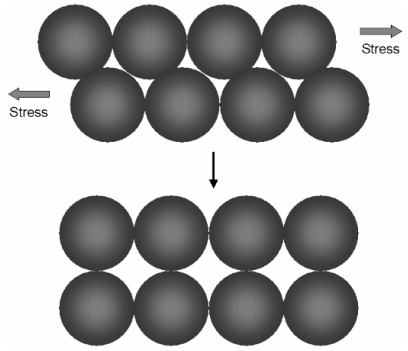


http://www.sciencechannel.com/tv-shows/street-science/street-science-videos/oobleck-acts-as-both-a-solid-and-liquid/

Dilatancy

Tauer, Polymer-Dispersionen, https://www.mpikg.mpg.de/886847/Polymer_latexes.pdf

Dilatancy is a rheological phenomenon. A dilatant liquid shows viscosity raise as the shear rate is increased. Or in other words when a rod or a stirrer is moved at higher velocity in the liquid it thickens. With the polymer emulsion shown in the experiment the effect has been driven to an extreme. The emulsion consists of small polymer particles of ca. 300 nm. As long as the shear rate is low, e.g., during pouring or slow stirring it stays thin. The particles order themselves into rows or planes that can pass each other with only little friction. The liquid flows easily. As the rod is rapidly pulled out the applied shear rate increases, the order of the particles is completely destroyed. They interlock and can not move independently any more. The whole system is converted into a solid like state. It now can transmit forces that the beaker can be lifted.

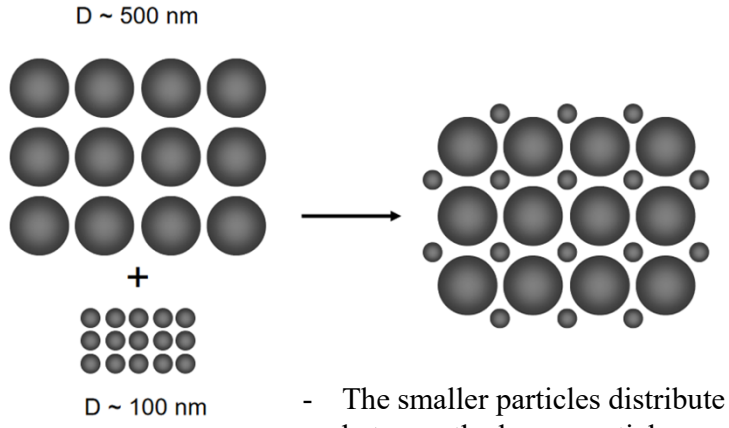


"Stress makes tough"

- Stress shifts the particle layers in highly concentrated emulsions so that the space between the particles increases.
- Water cannot redistribute quickly enough- subsequently the latex solidifies (walking on the beach).

"thick + thick = thinner"

This experiment shows that the viscosity of a polymer colloid strongly depends on particle size distribution. The first polymer colloid contains small polymer particles with a diameter below 100 nm. The second consists of particles with a diameter of bigger than 500 nm. Both polymer colloids are pasty, their viscosities are high. After mixing the resulting dispersion has a bimodal particle size distribution and the viscosity is much lower than either one before. The small particles fill up the space between the big ones and the more diverse mixture is flowing more freely.



- The smaller particles distribute evenly between the larger particles.
- Subsequently water is "released" ad the dispersion diluted.

Shear Thickening Fluids

Shear Thickening Fluids: Future Protective Materials for First Responders, Football Players, and Astronauts (Rebroadcast) November 2022,
https://www.acs.org/content/acs/en/acs-webinars/library/shear-thickening-rebroadcast.html?sc=221121_comm_webinar_em_belowthefold

The next generation of protective equipment is looking a lot less bulky and a lot more fluid. Shear thickening fluids (STFs) are novel field-responsive materials that can be engineered to be useful nanocomposites for enhanced ballistic and impact protection, puncture resistant medical gloves, energy absorbing materials for mitigating impacts and concussions, as well as in systems for mitigating micrometeoroid and orbital debris threats in space applications.

Join Norman Wagner of STF Technologies and the University of Delaware as he discusses the formulation, properties, and development of commercial applications of STFs.

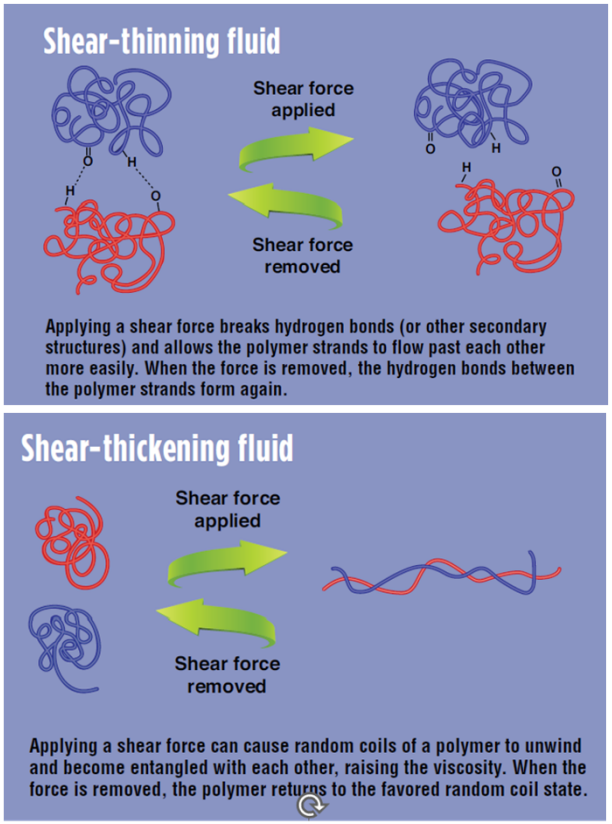
This ACS Webinar is moderated by Aaron Forster, of NIST and co-produced with the ACS Industry Member Programs and ACS Division of Polymer Chemistry.

Please note that you are watching an edited recording and therefore you cannot ask live questions to the experts. ACS Webinars will rebroadcast select recordings from the ACS Webinars Library as live webinars for free to the general public. All recordings are available right now as an exclusive benefit to ACS members with the Premium Package at www.acs.org/acswebinars.

What You Will Learn:

What Shear Thickening Fluids are and how they function
How to use Shear Thickening Fluids for puncture, ballistic, micrometeroid and orbital debris protective materials
How to use Shear Thickening Fluids for impact protection and concussion mitigation

D3O



What is D3O® Gel Made Of?
D3O® is a shear-thickening, non-Newtonian colloid.
Shear-thickening: These types of fluids become more viscous when under stress.
Non-Newtonian: Fluids that are affected by factors other than temperature (such as impact).
Colloid: A mixture in which one dispersed, insoluble substance is suspended throughout another dispersing medium.
• D3O® is made of a large molecular substance (also called a polymer) that suspends in an oily, liquid lubricant, classifying as a colloid.

How Does D3O® Technology Work?
These shear-thickening, non-Newtonian components are important to the performance of D3O because agitation and pressure (known as shear stress) affect the viscosity, or thickness, of non-Newtonian fluids in a way that makes it stronger:
When quick stress is applied to a shear-thickening fluid, polymer chains become entangled and confused, without enough time to rearrange. This creates a solid-like consistency as viscosity tremendously increases. Impact only makes it stronger.

Rohrig 2017, No-hit wonder D3O

https://www.zaggfranchise.com/blog/what-is-d3o/

Stress-Activated Friction in Sheared Suspensions

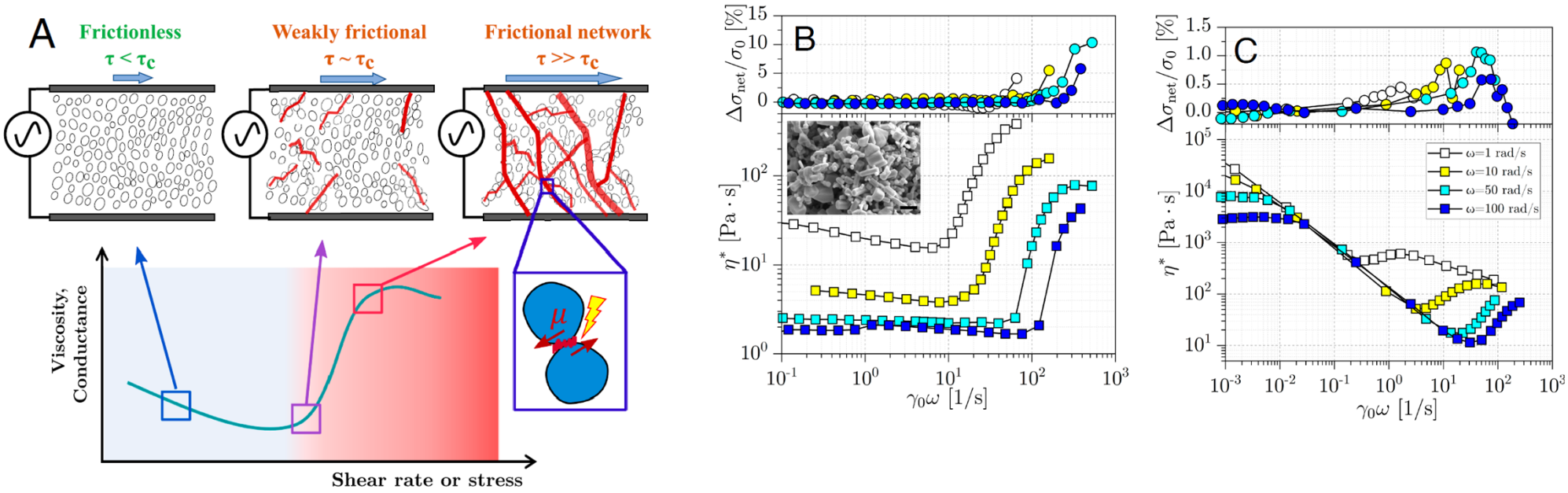
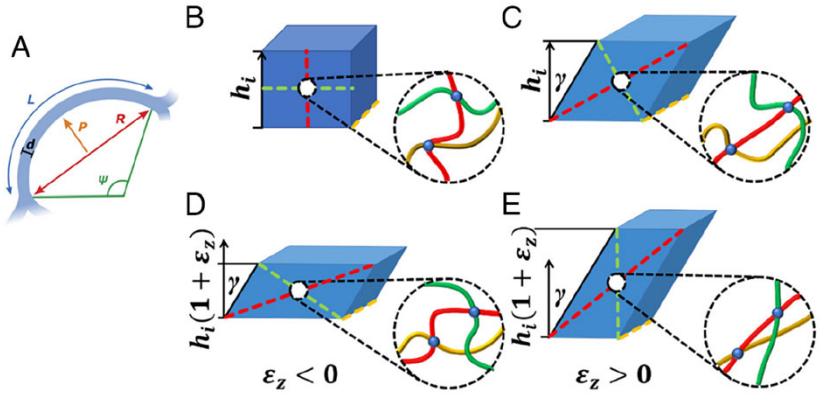


Fig. 1. Piezoelectricity signals emergence of frictional contact network in the shear thickening regime. (*A*) As a dense suspension of piezoelectric nanoparticles shear thickens due to a transition from frictionless (gray) to frictional (red) particle–particle interactions, friction-induced piezoelectricity in the contacting particles generates electric charge, which in turn increases the ac conductance of the surrounding fluid. (*B*) Complex viscosity η* (*Bottom*) and normalized excess conductance $\triangle\sigma_{net}/\sigma_o$ (*Top*) under oscillatory shear as a function of dynamic shear rate $\gamma_o\omega$ for ZnO nanoparticles (*Inset* Scale bar, 500 nm). The particles are suspended in glycerol at volume fraction ϕ=0.36. Stress-controlled oscillatory shear is applied with angular frequencies ω = 1 (white), 10 (yellow), 50 (cyan), and 100 rad=s (blue). (*C*) The same data as in (*B*) but for ZnO particles in glycerol with 100 mM of NaCl salt added, at volume fraction ϕ =0.33.

Kim 2023, Stress-activated friction in sheared suspensions probed withpiezoelectric nanoparticles

Stress-Activated Friction in Sheared Suspensions



Fibrous networks formed by biological polymers such as collagen or fibrin exhibit nonlinear mechanical behavior. They undergo strong stiffening in response to weak shear and elongational strains, but soften under compressional strain, in striking difference with the response to the deformation of flexible-strand networks formed by molecules. The nonlinear properties of fibrous networks are attributed to the mechanical asymmetry of the constituent filaments, for which a stretching modulus is significantly larger than the bending modulus. Studies of the nonlinear mechanical behavior are generally performed on hydrogels formed by biological polymers, which offers limited control over network architecture. Here, we report an engineered covalently cross-linked nanofibrillar hydrogel derived from cellulose nanocrystals and gelatin. The variation in hydrogel composition provided a broad-range change in its shear modulus. The hydrogel exhibited both shear-stiffening and compression-induced softening, in agreement with the predictions of the affine model. The threshold nonlinear stress and strain were universal for the hydrogels with different compositions, which suggested that nonlinear mechanical properties are general for networks formed by rigid filaments. The experimental results were in agreement with an affine model describing deformation of the network formed by rigid filaments. Our results lend insight into the structural features that govern the nonlinear biomechanics of fibrous networks and provide a platform for future studies of the biological impact of nonlinear mechanical properties.

anopar

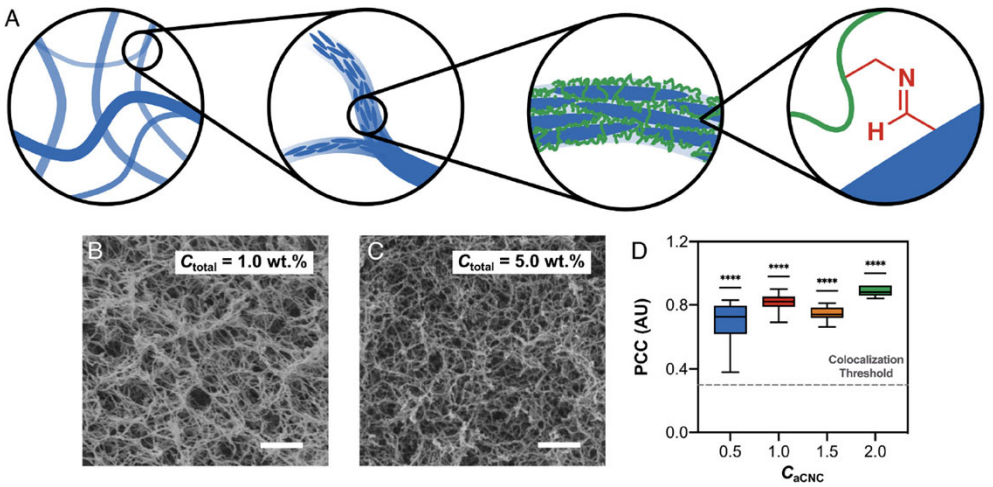
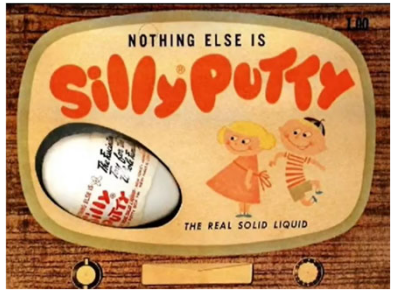


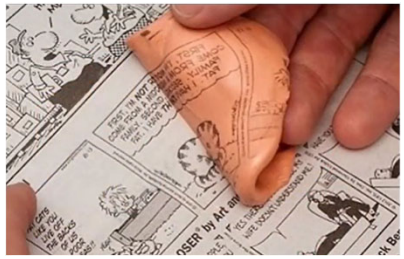
Fig. 2. Structure of EKGel. (*A*) Schematics of the hierarchical EKGel structure of the network (left cartoon), cross-section of individual fibers (middle cartoons), and the molecular level (right cartoon). (*B* and *C*) SEM image of EKGel with C_{total} = 1.0 wt% (*B*) and C_{total} = 5.0 wt% (*C*). In (*B* and *C*), C_{aCNC}/C_{gel}=1.0. Scale bars are 1 μm. (*D*) Pearson colocalization coefficient (PCC) of gelatin and aCNCs in EKGels with different C_{aCNC} and constant C_{gel}= 2.0 wt%. Boxes indicate mean SD, with whiskers indicating the minimum and maximum values. Analysis was performed on N = 11 images of different gel regions. One gel was imaged for each C_{aCNC}. The dashed line at PCC = 0.3 indicates the threshold for colocalization of aCNCs and gelatin. ****$P < 0.0001$, one-sample t test, hypothetical mean is 0.3.

Prince 2023, Nanocolloidal hydrogel mimics the structure and nonlinear mechanical properties of biological fibrous networks

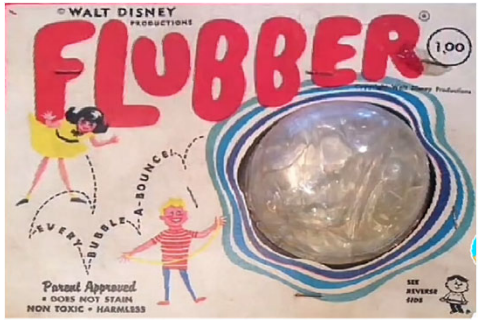
Polymers in Toys

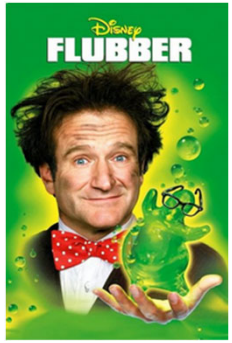
Silly Putty





Flubber

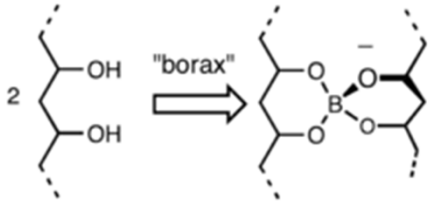




Flubber polymer with green food coloring added. The polymer is normally colorless.

https://en.wikipedia.org/wiki/Flubber_%28material%29

Flubber is a non-Newtonian fluid that flows under low stress, but breaks under higher stresses and pressures. This combination of fluid-like and solid-like properties makes it a Maxwell fluid. Its behavior can also be described as being viscoplastic or gelatinous.



The gelation process entails formation of a borate ester that cross links the chains of the PVA.[2] Borate esters form readily by condensation of hydroxyl groups and the B-OH groups.[3]

Now Elmer's Glue-All is an aqueous emulsion of poly(vinyl acetate), poly(vinyl alcohol), and propylene glycol distributed in plastic squeeze type bottles with twist-open dispenser lids. It is widely used in homes, businesses, and schools and effectively bonds most materials, such as wood, paper, and fabric.
https://cameo.mfa.org/wiki/Elmer%27s_Glue-All

https://laissezfairelife.com/2015/01/19/mad-craft-2-flubber-gak-slime-or-silly-putty/

Boric Acid Chemistry

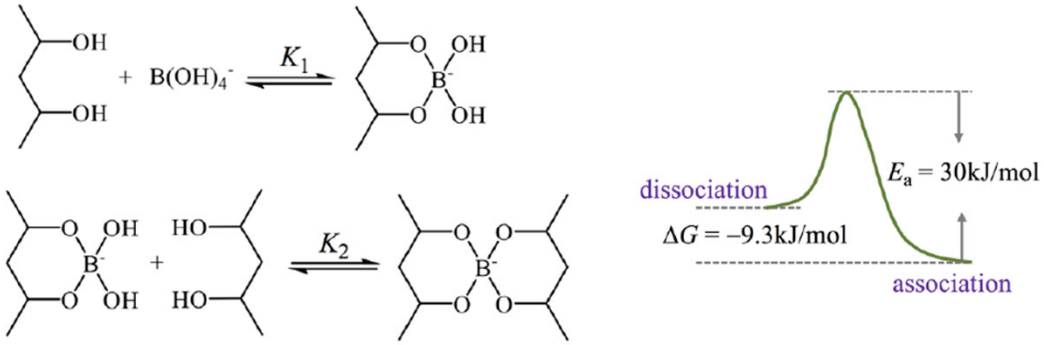


Figure 6. Top left panel illustrates the complexing between borate ions and PVA chains, and bottom left panel shows the diagram of energy corresponding to the complexing of the PVA and borate ions.

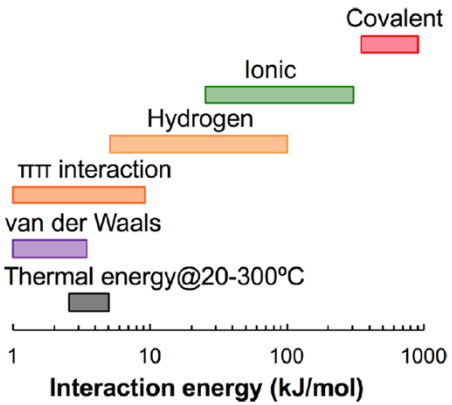


Figure 1. Comparison of the interaction energies of different types of interactions and the thermal energy kBT between 20 and 300 °C. Van Ruymbeke, E. Preface: Special Issue on Associating Polymers. J. Rheol. 2017, 61 (6), 1099−1102.

Wu 2021, Advances and new opportunities in the rheology of physically and chemically reversible polymers

Sevim et al. evaluated the kinetics of the boric acid dehydration reaction, assuming a two-step reaction (1) and (2). Following this assumption of two distinct steps, further kinetic analyses, without a clear separation of these steps, were performed by Balcı et al. and Zhang et al

$$2H_3BO_3 \rightarrow 2HBO_2 + 2H_2O\uparrow$$

$$2HBO_2 \rightarrow B_2O_3 + H_2O\uparrow$$

While examining different crystalline structures of boric acid, Harabor et al., however, observed three different thermal-induced reaction steps (3)-(5). The mass loss was attributed to each of this reaction steps. Based on this result, the kinetic analysis of Rotaru and Aghili et al. confirmed three distinct steps. Their experimental work, though, was not able to provide complete results for each of these steps because of a missing clear step separation. In 1978, it was already described that the “new” intermediate $H_2B_4O_7$ was part of the boric acid decomposition.

$$H_3BO_3 \rightarrow HBO_2 + H_2O\uparrow$$

$$HBO_2 \rightarrow \frac{1}{4}H_2B_4O_7 + \frac{1}{4}H_2O\uparrow$$

$$\frac{1}{4}H_2B_4O_7 \rightarrow \frac{1}{2}B_2O_3 + \frac{1}{4}H_2O\uparrow$$

Huber 2019, The multistep decomposition of boric acid

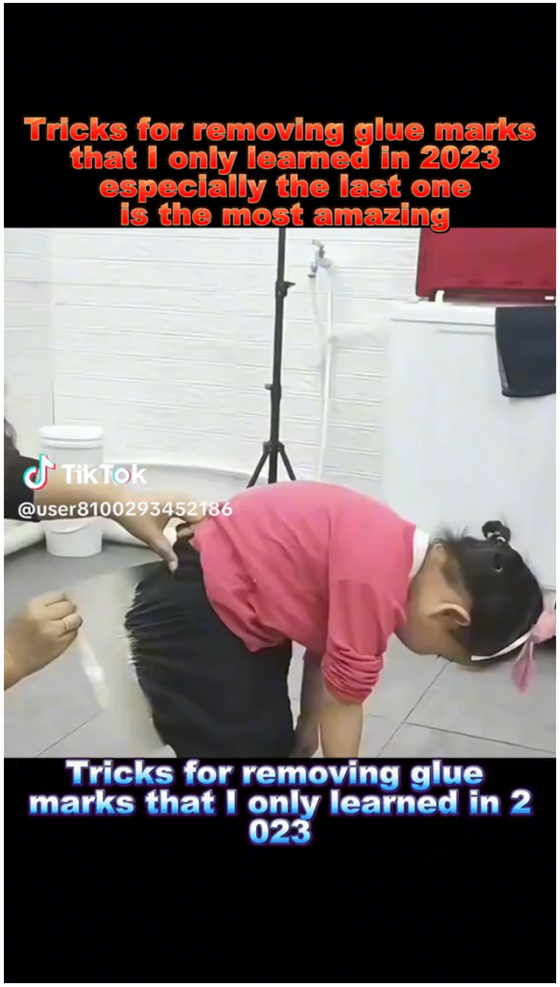
Hot Melt Glue

The primary polymers used in hot melts are ethylene-vinyl acetate (EVA), polyolefins, polyamides and polyesters, styrene block copolymers, polyethylene, and ethylene-methyl acrylate (EMA) or ethylene n-butyl acrylate (EnBA).

Polymers give hot melt its strength and flexibility, heat resistance, impact resistance, and shear. These characteristics are guided largely by the type of polymer, its molecular weight, and its amount.

With greater polymer content, you get a higher viscosity (which is a measure of the thickness of a liquid), and greater flexibility and toughness. With lower polymer content, there is lower viscosity.

https://www.hotmelt.com/blogs/blog/what-is-hot-melt



Eco-friendly for Hand-made Toys Children's Pellets Soft Creative Handicrafts DIY Tools Polycaprolactone Thermoplastic Crystal Soil Plastic

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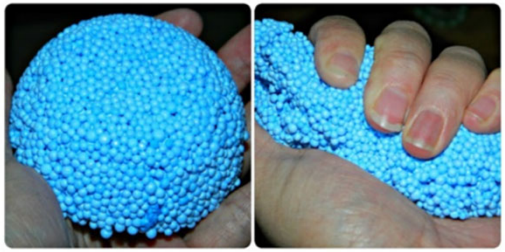
Toys



The 100 Best Inventions. 2021.
From bottles to blocks. Lego recycled brick
By Rebecca Katzman

About half of the world's PET plastic - which is used to make plastic water bottles and containers - winds up in landfills. Someday soon, a good amount could end up in Lego sets instead. The Lego Group, which has vowed to make all Lego bricks from sustainable sources by 2030, spent the past three years testing 250 variations of recycled PET materials, and in June finally unveiled its prototype for a recycled PET brick that is nearly identical to the usual brick. That milestone achieved, the Danish toy giant hopes to integrate the recycled blocks into Lego sets in the next 18 to 24 months. The impact could be considerable: the company uses some 100,000 metric tons of plastic resin in its products each year. (November 22, 2021)

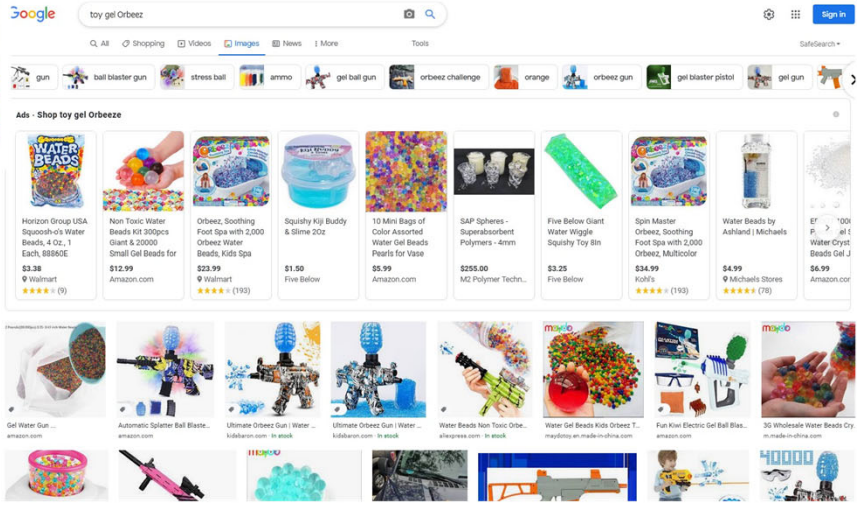
Super Elastic Bubble Plastic & Thing Maker

Poly(vinyl acetate) dissolved in acetone

Water Beads

Orbeez (https://orbeezone.com/en_us)

Poly(acrylic acid) (sodium salt) gel



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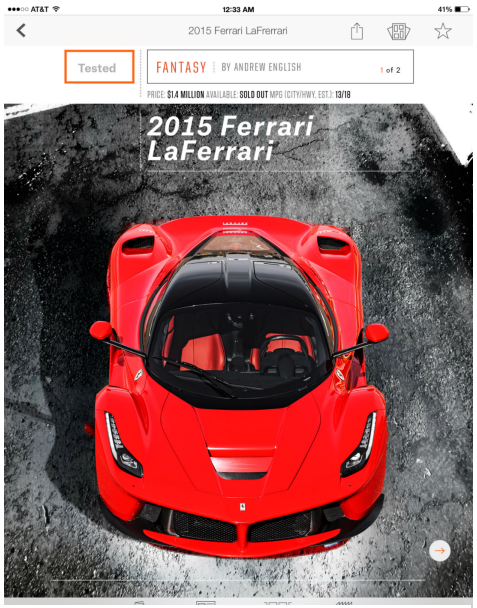
Polymers in Vehicles

Carbon Fiber in Real Cars



Carbon Fiber – A Material for Tomorrow's Technology

BY HUGH ASHTON

Toray's experience and expertise in carbon fiber technology is bearing fruit, as this versatile material finds a variety of new uses in many different areas

Of course the hood extractor is real carbon fiber, and of course it's functional. Directing hot air from the radiator out over the top of the car, the extractor helps cool the engine and improves overall aerodynamics.

Tested | FANTASY 2 of 2

IT'S A HYBRID.
Because the nutcase Ferrari engineers deemed the mid-mounted, 789-hp V-12 not powerful enough, they added an electric motor that generates 161 hp and 199 lb-ft of torque. It's positioned behind the seven-speed, dual-clutch gearbox and sends juice directly to the transmission. The batteries add an extra 132 pounds, but they also give the car its ferocious punch.

THE SPECS ARE GASP-WORTHY.
The total output is 950 hp and more than 664 lb-ft. It leaps from a standstill to 60 mph in less than 3 seconds. It tops out at 217 mph. Which is probably part of the reason all 499 of them are already sold.

THE BATTERY PACK IS BULLETPROOF–WELL, ALMOST.
Mounted on the floor behind the rear seats, the 2.3-kwh lithium-ion array built by Samsung is armored with a layer of Kevlar to protect it from road debris.

IT'S HANDMADE.
Just like those of Ferrari's F1 cars, the LaFerrari's chassis and body are made of hand-laid carbon fiber.

THE AERODYNAMICS ARE ADJUSTABLE.
Air movement around the car is constantly adapted to the driving situation. A giant rear spoiler deploys out and up; flaps in the front and rear open and close to regulate underbody airflow; and a vane in front controls air to the radiator. At 125 mph the car generates up to 1100 pounds of road-adhering downforce.

ELECTRIC POWER ASSIST MEANS NO LAG.
Squash the throttle down and the LaFerrari responds with full acceleration in 0.1 seconds. It's the first road car we've driven that makes the straights on a track more frightening than the turns. This is the best thing to come out of Italy since Monica Bellucci.

Carbon Fibers

DECEMBER 2014 — Best of What's New

Engineering

REPORTED BY AARON SEWARD + LOIS PARSHLEY

A CABLE THAT WILL RESHAPE SKYLINES

Of all the physical constraints that dictate our cityscapes, perhaps the most counterintuitive is the elevator cable. Very long standard cables become too heavy to haul, a limitation that restricts the height of buildings. But UltraRope, a new cable with a carbon-fiber core and high-friction coating, could double elevator heights to 3,280 feet. UltraRope weighs 80 percent less than a standard cable, with no loss in strength, and designers are already using it to build higher than ever; with UltraRope, the elevator shafts in the new Kingdom Tower in Jeddah, Saudi Arabia, will reach a record 2,165 feet. The lighter material also helps new buildings reduce energy consumption by up to 45 percent.

IN 2006, Darpa, the Departmer of Defense's R&D arm, commis sioned AeroVironment, a comp specializing in remote aircraft, create an unmanned aerial veh (UAV) small enough to fly through an open window. AeroVironment had already built the 4.5-foot-wingspan Raven, which first saw combat over Afghanistan in 2003, but making a UAV so much smaller took five years and 300 different wing designs. Finally, AeroVironment has a working prototype: the 6.5-inch-wingspan Nano Hummingbird. "It was never our intention to copy what nature has done; it's just too daunting," says Matt Keennon, the UAV's head researcher. The camera-equipped bird beats its wings 20 times a second, whereas hummingbirds clock up to 80. Still, it can hover like the real thing, plus perform rolls and even backflips. Here's how the bird flies. —JOSHUA SAUL

Carbon Fiber Reinforced Plastic

News Analysis & Commentary

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38 Why Apple traded in its chips
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48 DreamWorks spooks Wall Street

AEROSPACE

A PLASTIC DREAM MACHINE

Boeing thinks its new 787 jet, built mostly of plastic composites, could remold the airline industry.

BY STANLEY HOLMES

INSIDE BOEING CO.'S CAVERNOUS development center in Seattle, the future of its commercial jet business is taking shape. That future is plastic—and lots of it. At center stage in the tightly guarded building are three huge fuselage sections, dubbed barrels, made entirely of composites known as carbon fiber-reinforced plastic. Engineers swarm over the structures, looking for imperfections that could weaken the wafer-thin yet granite-tough material. Over in one corner, mechanics are sculpting the world's biggest composite aircraft wing.

Nothing on this scale has ever been attempted with composites, which are used in everything from golf-club shafts and tennis rackets to giant underground storage tanks. But even the latter can't measure up to what Boeing is creating—namely, the entire airframe of its upcoming 787 Dreamliner jet.

Boeing knows this is a gutsy, bet-the-company move. But after falling behind archrival Airbus in sales over the last four years, executives felt they had to come up with game-changing technology that would captivate financially strapped airlines.

So far the strategy looks like a winner. Boeing is heading into the Paris Air Show in June with 266 orders and commitments for the Dreamliner from 21 customers. That makes the 787 one of the fastest-selling commercial jets in history. And the plane is already playing a key role in a remarkable reversal of fortune between Boeing and Airbus (page 35).

VALUE ADDED

THE REASON THE 787 is selling so well is simple: Customers get tremendous bang for their bucks. For $120 million—about what they paid for the comparable Boeing 767-300 back in the 1980s—airlines get an all-new aircraft that flies faster than the competition and costs substantially less to operate. That's compelling at a time when fuel prices are high and airlines are just emerging from the worst industry recession ever. Combined with more fuel-efficient engines, composite materials are "changing the paradigm of

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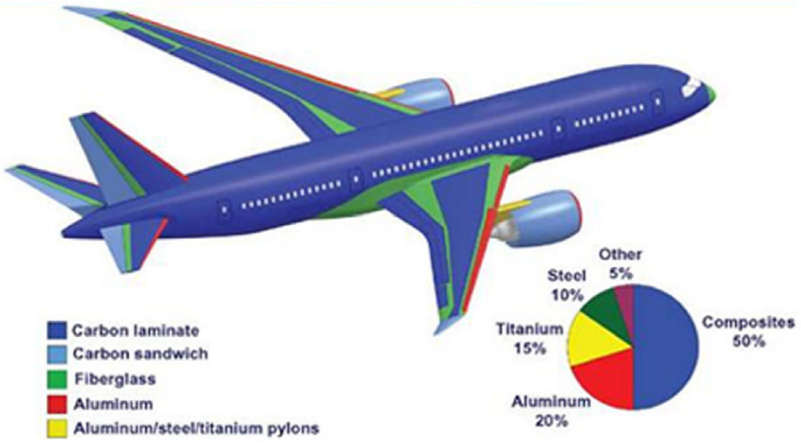
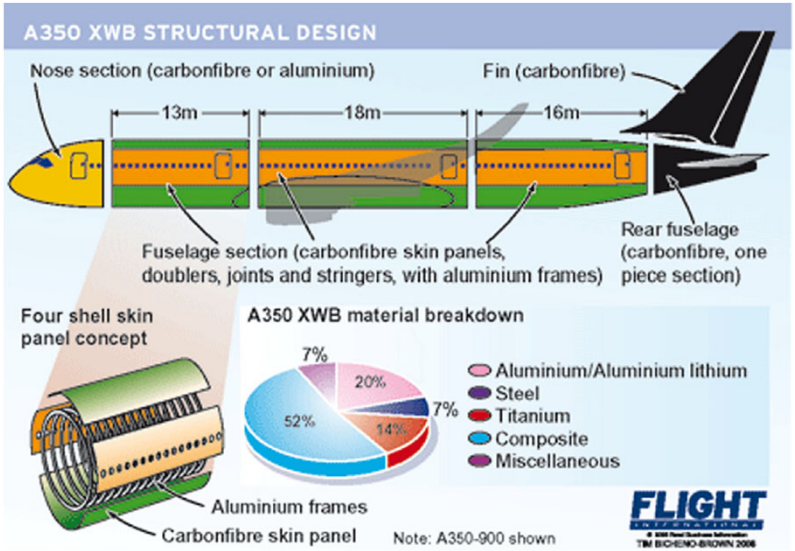
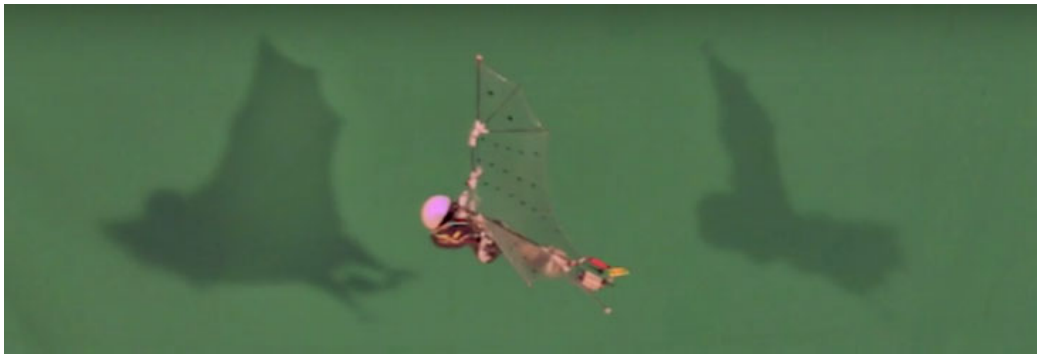




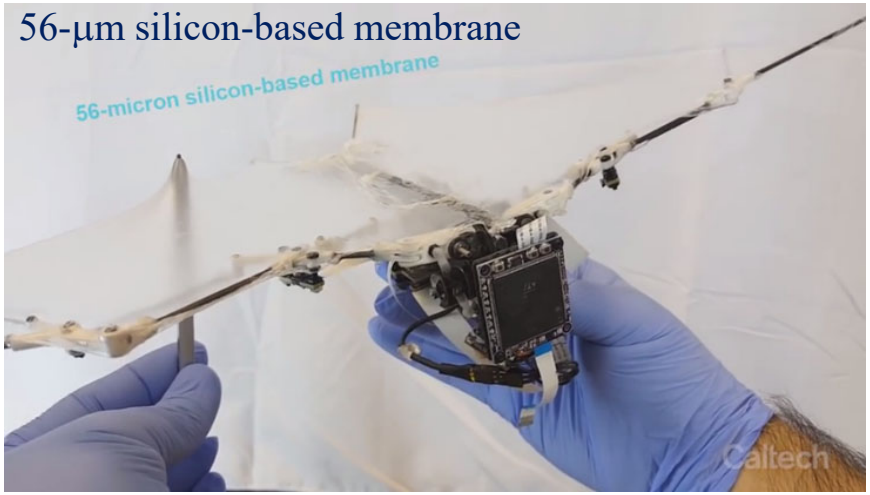
Giurgiutiu 2022, Introduction. Stress, Vibration, and Wave Analysis in Aerospace Composites

Advanced Robotic Bat Can Fly Like the Real Thing

Bat Bot B2 (Caltech)
A biomimetic robotic platform to study flight specializations of bats
Engineered by Alireza Ramezani, Soon-Jo Chung, and Seth Hutchinson

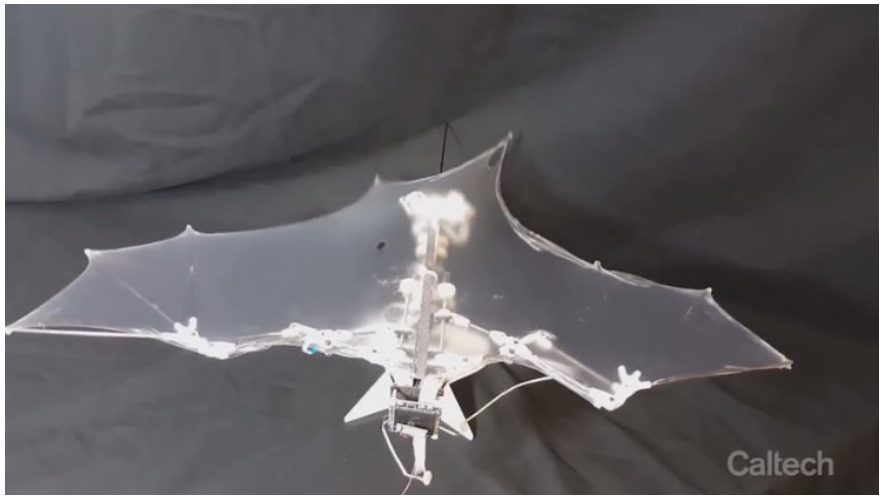


56-µm silicon-based membrane



The U.S. military seems to believe laser-powered bat drones could prove highly useful compared to the current drones it uses—primarily for surveillance and targeted killings—that are largely constructed based off conventional aircraft designs, especially when it comes to maneuverability and stealth. It also sees "wireless power transmission" (charging up the drone with a laser) as a potential solution to various energy challenges.

Ultimately, the goal of the initiative is to create platforms that "effectively navigate a battlespace and respond to obstacles with minimal intervention from a human pilot," according to the announcement. It appears the battlefields of the future could very well include swarms of bat drones zigging and zagging through the air.



http://www.newsweek.com/us-military-wants-bat-drones-lasers-because-life-apparently-black-mirror-772827?utm_source=email&utm_medium=morning_brief&utm_campaign=newsletter&utm_content=headline&spMailingID=2752404&spUserID=MzQ4OTU5MTEyMTQS1&spJobID=950270956&spReportId=OTUwMjcwOTU2S0

Jetman

A new feature length documentary will soon be premiering revealing more details about the story of the Jetman and the extraordinary steps taken towards complete autonomous personal flight. The documentary will feature Jetman pilots Yves Rossy, Vince Reffet and Fred Fugen are seen flying in formation through the fjords of stunning Norway, check out the 4K ultra HD teaser trailer for LOFT: The Jetman Story.

“Jetman is the culmination of 25 years of innovation and is set on the path to achieving what has long been thought as impossible. Driven by his desire to “fly like a bird,” Swiss military-trained pilot and aviation enthusiast, Yves Rossy, designed and built what is today known as the Jet-wing. “

“A man pursues the dream of autonomous human flight by inventing a Jet-Wing, he recruits two protégés to join his journey, together they must overcome the gravity of reality to obtain ultimate freedom. Jetman Dubai is the future of flight and freedom. Today, our trained and experienced pilots are powering their way towards autonomous human flight. Join the journey that will create a future for individuals flying with Jet-wings and that will one day change the way we experience the world.”

For more details on the jet propelled flight suit and the upcoming documentary LOFT, jump over to the official Jetman website by following the link below.

The system he designed contains rigid wings made of a carbon fiber, with Kevlar reinforcements and tiny jet engines. He told Wired that his first jet-powered flight was "totally crazy."

https://www.geeky-gadgets.com/jetman-documentary-12-11-2018/

https://www.mnn.com/green-tech/transportation/stories/jetman-ascendant-how-yves-rossy-learned-to-fly-with-four-jet

Wingsuit Flying