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+ Natural and Chemical Fibers
+ Bleach as a Part of Daily Life

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Dear readers,

Spring sets free her ribbon blue
to flutter in the skies again.
Sweet, familiar fragrance drifts
full of promise o'er the land.

These were the words of the great German romanticist Eduard Mörike in the middle of the 19th century …

… and as in every year, all eyes delight in the blooming flowers and lighter fabrics we wear in spring.

Richard Huber
Head Marketing & Communication Manager

But what is it we wear that warms our bodies in winter and keeps them cool in summer? Cotton? Synthetics? Microfibers? In one of its many sessions, the FIZ CHEMIE +report+ editorial team asked what kinds of fibers are in use. When researching the topic of fibers and textiles, it quickly became apparent that the subject could be pursued endlessly, so we decided for an emphasion natural and artificial fibers.

Can we learn about fibers from animals? How is spider silk made? Which fibers are suitable, for example, as materials for bullet-proof vests like police wear? Can clothing provide support for sportsmen? What can we do if our apparel becomes discolored?

Enjoy reading the current issue of +report+ 2009 …

Richard Huber

Foreword from the management

Sitting in her web, the garden spider is unsurpassed in her mastery of processing fine structures with the most delicate linkages of dozens of threads, knots and breakpoints. On close inspection, the web reveals itself as a natural invention of genius.

For spiders, it is a tool for catching prey – but is that all?

There is much more to the web as a structure. It is a map of our human thought, indeed of any of information supply networks of any kind. It has a basic substance which is hardly measurable and yet it connects many points, forms nodes and branches and offers many paths to the same goal. The web is a structure which can hardly be touched. The spider's tender weave is in some sense symbolic of virtuality. It appears to float in space, nearly self-supporting, resistant to the law of gravity in its sparse construction. And yet it is an unbelievably stable structure. We see this when the spider catches a large moth in its web. One would think that the large insect could free itself quickly and effortlessly from the thin threads. But they remain strong and entangle the victim ever more firmly.

We communicate via our networks of relationships, education and information. Though we might not be conscious of it, a web structure is found not only on the World Wide Web but in all aspects of development in society, human research and growth.

And that is even quite relevant. The nerve cells of our highly developed cerebral cortex form new network structures with other nerve cells as part of every learning process and experience. Our body's blood vessels form a tight network for supplying even distal members with blood and nutrients. The Internet is a single large network of interwoven individual information which has taken on a life of its own which in its complexity is long since beyond the grasp of the individual producers of information.

Prof. Dr. René Deplanque
Managing Director

Since its founding in 1981, FIZ CHEMIE Berlin has networked partners worldwide to supply information for the natural sciences and technology. Its central mission is the provision of information and information technology to stakeholders in business, science and education. FCH is associated with and supported by networks which are initiated and created new by us at the same time.

Prof. Dr. René Deplanque

Spider silk – the ultimate in fiber technology

Admittedly, it does look silly if some fellow in red and blue tights swings on threads from skyscraper to skyscraper to battle the evil forces of this world. But one has to cut Spiderman slack on this one: the fibers shooting from the spinnerets in his wrists would probably be the only material in this world which would actually make such breakneck acrobatics possible.

The material properties of spider silk are impressive. A spider's main thread is ten times thinner than a human hair. With a unique combination of great elasticity and enormous tensile strength, its properties even exceed those of steel or Kevlar. The polyamide Kevlar, for example, can only stretch its length by 4 % before breaking, but the draglines of many spiders can stretch as much as 30 %. Such material is of great interest for various technical applications.

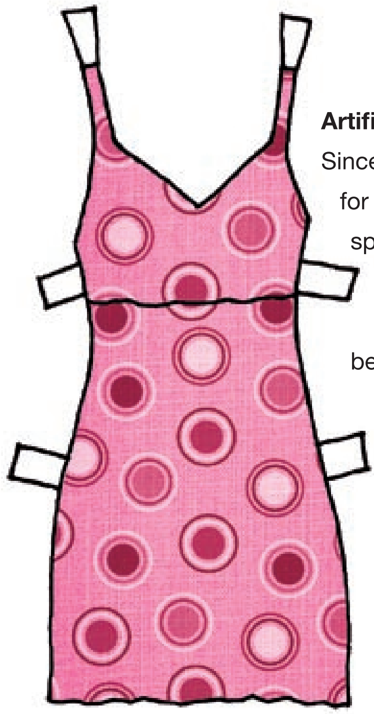
As far back as the 18th and 19th centuries, natural spider silk was used as an exotic fiber for textiles. However, profitable production of spider silk for socks or gloves failed due to a logistical problem. Spiders are not very social animals; indeed, they like to eat each other. Avoiding the cannibalistic drive these eight-legged weavers requires each spider to be kept individually, an effort which ultimately makes commercial operation uneconomical. Today, natural spider silk is used particularly for extremely thin marking lines in some optical measuring equipment or for crosshairs.

Determining the structure of spider silk – no easy undertaking

Spider silk is so promising as a material that attempts to make the fiber artificially are made time and again. First came success in determining its composition and structure. Spider silk is a polymer made of amino acids and a protein; from a purely technical viewpoint it is a polyamide. The properties of different spider silk fibers result from the variation of the amino acid composition and determine the suitability as dragline, web material, "wallpaper" for the lair or cocoon fiber. Moreover, capture silks and the radial fibers of a spider web are not adhesive by themselves. The spider applies drops of adhesive or capture silk, a very sticky network of the finest threads just 10 to 15 nanometers in diameter.

Spider silk consists predominantly of amino acids with short side chains. The molecular weight of the fluid silk precursor in the spinnerets is tens of atomic thousands of mass units. In solidified silk threads, the molecular weight increases to hundreds of thousands of AMUs. What has not been entirely clarified is the complex structure of the various spider silk proteins. Module groups of identical peptides form individual clusters of pleated sheet structures, which are separated by spacers of unordered chains of amino acids or helix structures.

For a long time, it was not known how the spider spins the liquid protein in the glands of its spinnerets to form a solid strand. On the chemical side, the addition of potassium phosphate and acids ensures the formation of the pleated sheet structures typical for spider silk. The structure of the spinning apparatus is also of decisive importance. At the end of it, the outlets of the various types of glands come together. By selecting glands, silk spigots and spinnerets, the spider can produce the required strand material as needed in each case.



Artificial spider silk

Since living spiders are unsuitable for producing large quantities of spider silk, methods involving genetic technology had to be developed. Bacteria can be genetically modified to synthesize the soluble spider protein for the particularly interesting draglines. At first, these efforts were unsuccessful in producing usable fibers. Finally last year, a biophysics team at the Technical University of Munich succeeded in reproducing the process. The geometry of the artificial spinneret was critical to this success. It ensures the flow rate required to form a stable strand from the various spider proteins and chemical additives.

This experimental apparatus now makes it possible to study the processes for spinning artificial silk precisely and determine the parameters for producing fibers with particular characteristics. Even if a product application is still distant, this represents a great leap forward toward the goal of making this unique natural material available for human use.

Source:
Assembly mechanism of recombinant spider silk proteins;
S. Rammensee, U. Slotta, T. Scheibel, A. R. Bausch, PNAS 2008, 105. DOI: 10.1073/pnas. 0709246105

Application possibilities for natural and artificial spider silk

- light extremely resilient, yet elastic fibers for use in safety ropes or parachutes, for example
- protective clothing (sports gear and personal safety)
- renewable polymer raw materials
- medical suture material

+svg

Of dragon skins and other armor

There is no doubt that Man is not only the most intelligent but also the most warlike of all creatures to have evolved in more than 400 million years. Current reports on the oldest finds of human skulls from early hominids to modern *Homo sapiens* show clearly that a very great number of those who came before us did not depart this life peacefully. Numerous breaks and holes in the skulls show instead that our ancestors hundreds of generations ago had lots of experience in the use of blunt and pointed weapons for smashing, thrusting and throwing.

Just as old as the knowledge of weapon use is the human desire to protect one's own body against the effects of brute force. What the dragons of legend, rhinoceros and turtles were granted by nature was denied to our ancestors who increasingly felt their nakedness: armor which deflects or at least reduces the effect of weapons. The fear of pain or even death inspired the creative spirit of generations of people.

To protection especially sensitive and essential body parts, such as the head, upper body and hip area, armor such as helmets, shields and breastplates were developed in early times. They are found as grave goods dating back over 10,000 years. The history of body armor experienced its zenith in the Middle Ages with the knights, who were admired by contemporaries and others to this day. The armor worn became ever thicker to protect body parts against the projectiles (arrows from bows, spears and crossbow bolts) which were fired with increasing speed. With increasingly massive armor, weight and movement restriction reached a level, which combined with ever more effective striking weapons and projectiles, made warriors on the battlefield rather immobile fortresses which were easy to hit. Plate armor weighed up to 48 kg. Horses too were equipped with massive armor as well, so that they frequently collapsed under the burden.

The advent of firearms put an abrupt end to massive metal armor. Though thick metal armor might occasionally deflect a fired ball, the development of spin-stabilized, cylindrical bullets made plate armor utterly ineffective.

The modern equivalent of knights in armor of the Middle Ages is found in modern infantry soldiers in Iraq and Afghanistan today, with flak jackets, helmets and night vision gear.

Detail photograph of three statutes from the terracotta army from the mausoleum of Qin Shi Huang, an early Chinese grave from 210 BCE; the scale-like arrangement of metal plates on the armor of the warriors is clearly visible (photo: R. Huber)

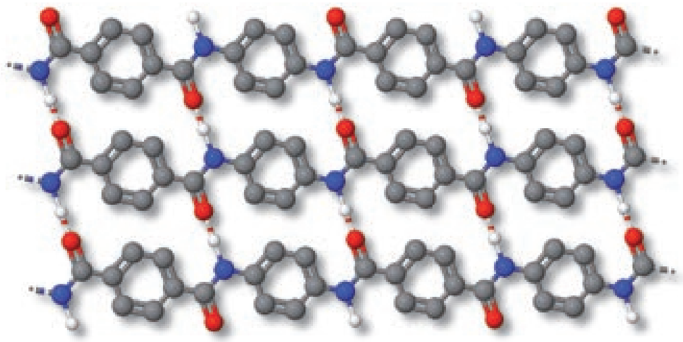
How are modern protective vests made? There are various classes of them designed to offer protection from the impact of bullets from today's firearms. This article attempts to give a small overview of the state of the art of modern bullet-proof body armor.

Material requirements for the manufacture of flak-resistant clothing elements are very complex. The clothing fibers must have high tear resistance but at the same time not impair the wearer's movements; weight must be low; and the material should not exhibit significant changes upon aging.

Aromatic polyamides (aramides) are well proven in real applications. Synthetic materials processed to make flak-resistant vests have a structure similar to protein and are marketed under trade names such as Kevlar or Twaron. They are produced by copolymerization of p-phenylene diamine and terephthalic acid.

Police in action; the vests for protecting the upper body from blows, stabbing and shots can be seen (photo: R. Huber)

The p-phenylene diamine order themselves in such a way during the spinning process that all polymer chains lie parallel to each other. This results in very high fiber strength.



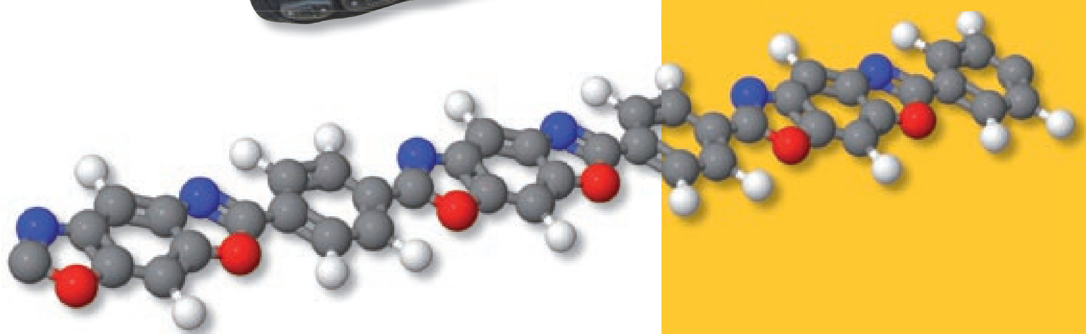
3D-structure of bridged aramid polymers

Another known material for the production of flak-resistant clothing is the fiber Zylon from a Japanese manufacturer. Zylon (IUPAC-name: poly(*p*-phenylene-2,6-benzobisoxazole) has tear resistance twice as high as Kevlar and a melting temperature of 650 °C. Its disadvantage is a strong susceptibility to UV radiation and moisture, which lead to a rapid loss of material strength.

A compromise between the highest tear resistance and good resistance to UV radiation, moisture and wear is the fiber material Dyneema. Ropes made from this polyethylene fiber have higher tear resistance than a steel cable of the same diameter. Bullet-proof vests made today with this material are considered among the safest protective gear on the market today, but also the most expensive.

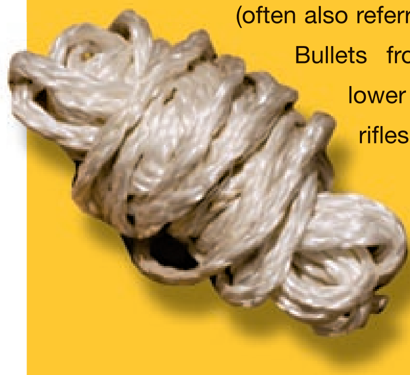
The basic principle of all flak-resistant armor is the same. The energy of an impacting shot is distributed over as large an area of the protective gear as possible and on the person shot. In body armor, the fibers are processed in multiple layers over one another. The energy of the impacting shot is dissipated while the projectile penetrates or distorts the individual layers of material. After penetrating some layers, the projectile stops. However, the projectile's energy is still distributed to the body part hit. The impact can cause bruises, contusions and possibly even broken bones in the body and extremities of the victim.

Kevlar gloves



3D-structure of a Zylon-trimer-fragment

Protective vests made of pure fiber material generally only provide protection against projectiles from handguns (often also referred to as soft ballistics). Bullets from these have much lower energy than those from rifles (hard ballistics).



Rope made of the fiber material Dyneema

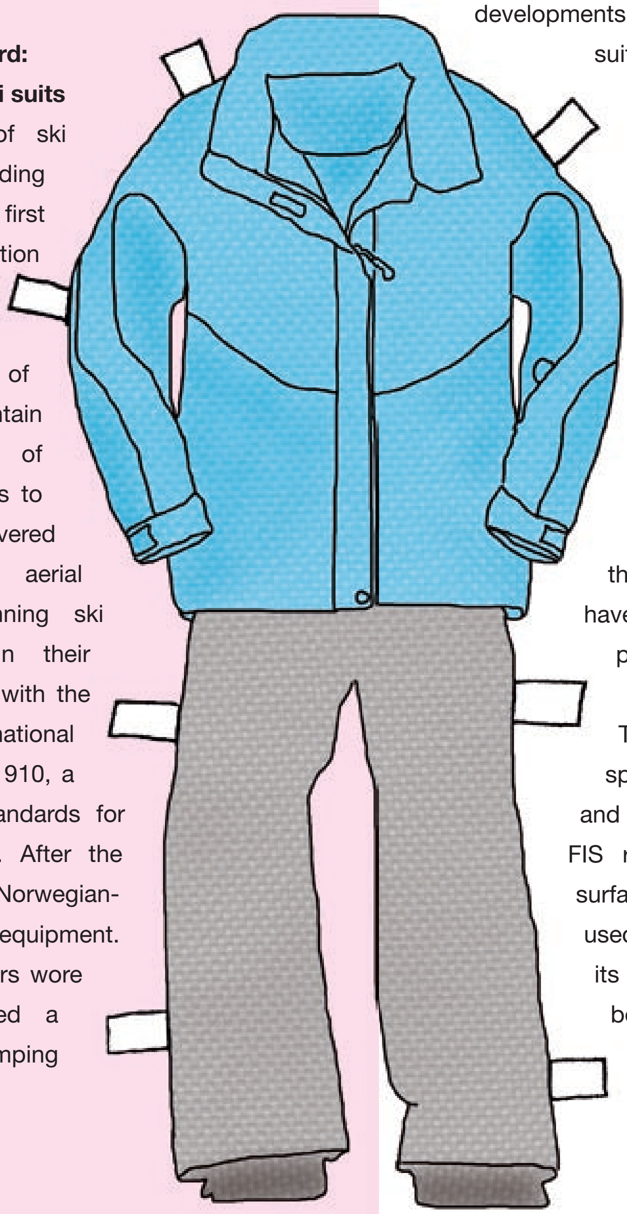
To protect against higher energy bullets from rifles, the fibers described above are frequently reinforced with plates of steel, ceramic or polyethylene. However, this makes the protective gear heavy and con-sider-ably red-uces the mobility of the wearer. To maintain good freedom of movement, today many protective vests use smaller plates with light overlaps like scale armor.

The development of increasingly tough, tear-resistant fibers is surely not at its end. In view of the numerous military conflicts and wars worldwide, the coming years and decades will see much research and advancement in weapon systems designed to defeat armor as well as protective gear to counter these. The article on spider silk on page 4 gives a little preview of future developments of even more tear-resistant, flexible fibers. +rh

The sportsman's new clothes

Things aren't easy for a sportsman. Added to the burdens of daily training and restricted diets come strict clothing requirements. This is true of every sport. Even in the ancient Greek Olympic Games, there were uniform requirements for athletic clothing: mostly "birthday suits". Today, however, manufacturers of sporting goods have other interests.
The commercialization of sports and attractive awards (who would show up today for an olive branch?!) was accompanied by the start of research in clothing for sports. In the course of time, rules and guidelines have been developed so that not only the consumption of stimulants but even incorrect sewing can lead to disqualification and/or a ban.

The Great Leap Forward:
the development of ski suits
The Olympic sport of ski jumping is an outstanding practical example. The first ski jumping competition took place in Norway toward the end of the 19th century. Hundreds of years before that, mountain farmers tied planks of wood under their boots to navigate the snowcovered slopes and practice aerial jumps. In the beginning ski jumpers competed in their everyday clothing, but with the founding of the international ski association FIS in 1910, a body of rules and standards for clothing were created. After the First World War, the "Norwegian-suit" became standard equipment. In the 1960s ski jumpers wore overalls which evolved a decade later into the jumping overalls used today.



Materials on the front side which are permeable to air and on the back side which are not have a balloon effect which leads to better lift and enables significantly greater jump distances. The FIS reacted with a requirement that the air permeabilities on both sides be identical.

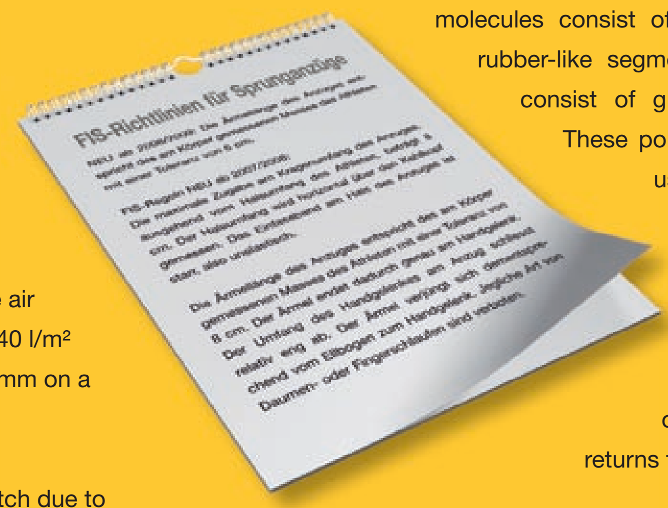
Since then teams are experimenting with the materials from which the jumping suits are made. Since up to then sport suits were made of natural fibers, the next big step was the introduction of synthetics. Highly elastic Lycra and Nylon are leading materials used. In conjunction with a thick layer of foam as a base, these new suits offered additional minor protection against bruises and injuries. The rule requiring identical air permeability on the front and back sides of the suit was expanded in the 1980s to include a minimum permeability to air. This led to new developments in the field of surface structure for suits.

A rough front side combined with as smooth a back side as possible proved to be particularly favorable. Especially thick foam inserts also contributed to new records. However, FIS stepped in once again and established the regulations for ski suits which apply to this day. Specifications for air permeability, maximum circumference and fit of the suits, method of manufacture, thickness and material workmanship have severely limited the range of possibilities.

The most recent edition of the specifications for competitive equipment and commercial trademarks from the FIS requires that the structure of the surface and condition of the material used for the suit must be the same in all its parts. The thickness of the suit must be at least 4 mm but not exceed 5 mm.

The suit material is constructed with a special five-layer laminate: top material, an elastic membrane covered on both sides with foamed material and lining.

The top material and lining must be made of 81 % polyamide and 19 % Lycra. In order to be permitted in competition, these components must be joined by a lamination process with adhesive or flame lamination. Here the materials are heated with flame on both sides to about 1,000 °C so that the sticky mass created ensures bonding. The air permeability of the suit material is also achieved by perforation and must meet minimum requirements for air permeability from the outside into the suit and out of the suit to the outside. The specifications of the international ski association state that the unstretched fabric must exhibit an average air permeability of at least 40 l/m² at a low pressure of 10 mm on a water column.



Even after possible stretch due to frequent wearing, the air permeability of the back part of the suit must be as high or higher than that of the remaining parts. If this is not the case, the lesser air permeability on the back side leads to the forbidden balloon effect. During the purchase of equipment, information from the manufacturers will be found indicating production according to particular standards. Thus the cut of a suit is specified as "FIS-standard side seam cut" and the material as "Meininger original laminate according to the FIS standard", for example.

Sporting success with chemistry
As mentioned, the required elasticity and stability of form for the suits is based on the synthetic fibers Nylon and Lycra.

The trade name Nylon was used in the middle of the last century as the first purely synthetic fiber for women's stockings. It is a synthetic polyamide and despite its long history, it is still one of the most important synthetic fibers based on quantity.

It weight (lighter than silk), elasticity and characteristics for dye application make it well suited for clothing manufacture. Moreover, Nylon is safe from moths and crease-resistant as well as resistant to rotting, alkali and tearing.

The trade name Lycra, also known as Spandex in the US, refers to the synthetic material elastane, which is used primarily in tight-fitting, elastic clothing. Elastane molecules consist of both rigid as well as flexible, rubber-like segments. The soft, flexible sections consist of glycol units with ether linkages. These polyether segments in the fiber are usually balled up in the fiber. Stretching these balled segments extends the fibers. If the stretching force is removed, the polyether segments contract to their original condition and the fiber returns to normal.

In conclusion here are a few more points from the FIS list. A sportsman's underwear must be no more than three millimeters thick; crash helmets are not permitted to have integrated or removable visors; aerodynamic formations on ski goggles are forbidden; and ski gloves are not permitted to have any fin-like form. There are also several pages devoted to the jumping ski, describing its geometry, design, aerodynamic covering, width, contour and much more.

In this regard, **chemistry is everything…**
… and everything is chemistry
In this regard, **being part of the game is**
all that counts +lau

Oh dear! The stain must come out!

With good intentions and anticipation a few friends were invited to dinner: Max, Ellie, Frieda and George. To make the occasion a bit finer, a quick call was made to the neighbor to borrow a fine table cloth. (The old one from IKEA would have been enough, but you know how it is... with age comes the desire for more "respectability".) It was indeed a great evening. The memory of the evening is a bit hazy, but in the morning after, it became clear that borrowing the tablecloth wasn't such a hot idea after all. What used to be pure white with delicate embroidery now resembles a work of modern art, splashed with a wild variety of color. When reaching across the table to clink glasses with Frieda during a toast, Ellie spilled half the glass of red wine, smashed the glass itself in her enthusiasm, cut herself and quick-wittedly wrapped the bleeding wound with the tablecloth. The evening's menu, featuring spinach and buttered potatoes among other things, combined with George's gross motor skills to add accents of green and yellow. Candle wax added a beautiful, three-dimensional effect. And for the final touch, in the after-dinner card game, Max wasn't as alert as usual and missed the paper sometimes while keeping score with his blue pen.

What now? What can one do? The first impulse was to get a new tablecloth, the second to use a stain remover. After all, there's one for nearly every kind of stain these days. So things were taken step by step.

An initial analysis revealed that the spots on the tablecloth clearly fell into the category of "tough" stains. But what are these stains actually? Hygienic science defines them as the wrong material at the wrong place and time. That's not very helpful. It makes more sense to classify stains, dirt and grime according to their chemical constituents and properties.

There are easily soluble stains, such as those composed primarily of carbohydrates, salts and some water-soluble proteins. Fats, oils or waxes (in the general category lipids), like all other components which are insoluble or barely soluble in water are already much harder to remove. And worst of all is when the staining material reacts with the surface of the textile fibers. Cotton consists of cellulose, which has free hydroxyl groups (see also +report+ page 15–16). Many dyes, for example, can form stable bonds with these groups and are correspondingly difficult to remove from the textile.

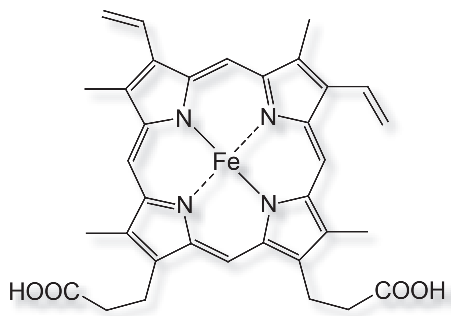
Cleaning basically works by removing the impurities from the textile surfaces and carrying them away. The removal can use mechanical or physical/chemical principles (dissolution in cleaning agents or chemical reaction). The undesirable particles must then either be dissolved or dispersed for removal.

Now let's get back to our tablecloth. After the candle wax was scratched off the surface, (mechanical cleaning), more is removed using a hot iron and paper towels, which melt and remove the wax (physical cleaning).

What remains is a fatty spot or lipid stain. Beeswax – these were good candles – consists of 70–80 % fatty acids and hydroxy fatty acid esters of higher molecular weight alcohols. Another fat stain is from the butter, which contains saturated and well as single and multiple unsaturated fatty acids (C4 to C18).

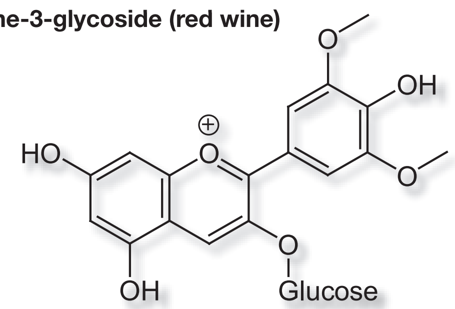
As Goethe wrote, blood is a very special juice, and that also applies to cleaning bloodstains. The proteins contained in blood denature in part at just 42 °C. This means that along with hydrophobic bonds, hydrogen bridges are broken which stabilize the tertiary and secondary structure. This causes the denatured protein to stick firmly to the fiber. Thus stains containing proteins should always be washed out with cold water. Moreover, the removal of the red coloring from blood – hemoglobin – or more specifically the heme groups containing iron (II), is a much more difficult challenge. The π system of the porphyrin ring in combination with the divalent iron ion here cause the deep red color by absorption in the visible range of the spectrum.

Heme group (blood)

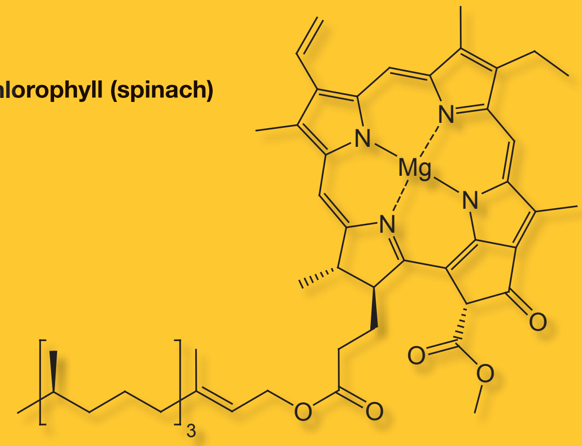


The three other stains are also distinguished by their color, arising from delocalized π systems in the associated colorant molecules. The colorants in red wine belong to the material group of anthocyanins – secondary plant materials of which several hundred various compounds are known. One of the most frequent occurring pigments is malvidine-3-glycoside. For spinach, the coloring agent is chlorophyll, and the blue color of the ink from the ballpoint pen comes from Victoria Blue.

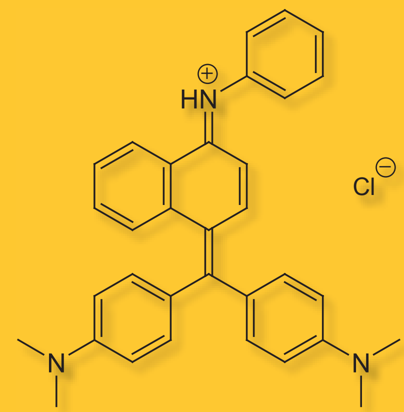
Malvidine-3-glycoside (red wine)



Chlorophyll (spinach)



Victoria Blue B (ballpoint pen ink)

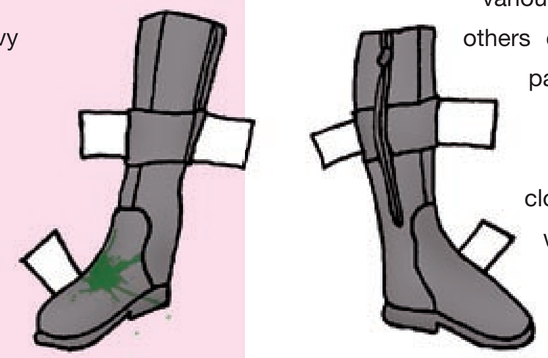


Since all the bad actors have now been identified, let's talk about how to get rid of them:

Most conventional laundry detergents contain surfactants, softening agents, whiteners, enzymes and activators in various combinations – as well as other ingredients which are not directly responsible for the cleaning action. The most important active components are the surfactants. These molecules consist of a hydrophobic (water-repellent) hydrocarbon portion and a hydrophilic (water-attracting) one which aids in dissolution. The hydrophobic part holds the particles of dirt while the hydrophilic part ensures good water solubility, enabling the dispersed dirt and grime to be carried off. Depending on the charge of the hydrophilic group, a distinction is made between anionic surfactants (such as alkylbenzene sulfonates [ABS] and fatty alcohol sulfates [FAS]) and non-ionic surfactants (such as polyalkylene glycol ethers and alkyl polyglycosides). The latter are finding increasing use due to their skin friendliness and lesser sensitivity to water hardness.

Most surfactants are limited in their effectiveness by the calcium and magnesium ions which cause hardness. Softening agents such as sodium triphosphate, ethylenediaminetetraacetic acid (EDTA) or zeolites remove these and other metal ions by forming complexes. Whiteners oxidize molecules of grime and convert them to water-soluble compounds. The most common substances here are perborate ($NaBO_2 \cdot H_2O$) and percarbonate ($2\ Na_2CO_3 \cdot 3\ H_2O$). With both compounds, hydrogen peroxide is split off above 60 °C; in the wash this decomposes by basic catalysis to form hydroxide ions and atomic oxygen, which is much more reactive than the molecular form. To bleach at low temperatures, activators (such as tetraacetylethylenediamine or TAED and 1,3,4,6-tetraacetyl glycoluril or TAGU) must be added. In the alkaline medium, these form an active bleaching compound, peroxyacetic acid, by reaction with the whitener even below 60 °C.

Finally, enzymes degrade organic macromolecules by splitting them into smaller molecules which are mostly water-soluble. Proteases are used for protein compounds, amylases for starches and lipases for fat stains. However, enzymes only work optimally within a particular temperature range and are also sensitive to other ingredients, such as the whiteners. The ongoing development of new, more active, stable and economical enzymes is therefore an important field in the laundry detergent industry today.



Thus in principle a conventional heavy duty laundry detergent contains all the substances needed to clear the tablecloth mentioned. Surfactants and lipases for the fatty stains (butter and wax), whiteners to oxidize the colorants (spinach, red wine and ballpoint pen stains). The ring system which gives the colors with its delocalized electrons is destroyed, and proteases remove the proteins (in the blood). So what is the point of special stain removers?

The secret lies in the interplay of five factors: time, temperature, chemistry, biology and mechanics with thesolvent (the cleaning cycle as per Sinner).

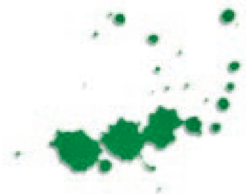
Individual treatment of the stains enables a longer period for action, a higher concentration of the active substances, avoidance of undesired interactions, individual temperature setting and any necessary mechanical support (such as rubbing or brushing).

Furthermore, stain removers can contain special, highly effective surfactants or solvents which cannot be used for treating large areas due to environmental or health issues. Thus, for example, commercial stain removers for colored stains often contain additional organic solvents such as N-methyl-2-pyrrolidone, which is irritating and not very volatile.

In any case, the principle applies that stains are easier to remove while they are fresh. Aging leads to decreased solubility and/or dispersibility due to drying. The dirt and grime then bond more strongly due to chemical reactions on the surface, and organic contamination can also be decomposed by microorganisms, producing new contamination. With new stains, it is often not necessary to use special stain removers. Even "home remedies" often work Table has some (untested) suggestions for the various we dealt with here. Many others can be found on helpful web pages on the Internet.

So what became of the tablecloth? After all the research and writing involved with this article, the stains were no longer so new. I confessed to the neighbor and bought her a new one.

+kh



Stain Removal

Stain	Removal
Red wine	White wine helps to remove red wine. Even sherry or clear alcohol fights the stain with a high degree of reliability. But the best approach is to apply a big dash of salt. In any case, it is a good idea to treat the stain as quickly as possible. Before you turn on the washing machine, it is recommended to spray some lemon juice on the spot. If that doesn't do it, place the material overnight in buttermilk before the next wash. If that still doesn't help, give glycerine a try at last.
Wax	Wax spots can be ironed out easily. First, carefully scratch off the largest residues of wax. Then place the stained material between blotting paper, paper bags or paper towels and iron it at a low temperature from the inside to the outside over the wax. Change the paper often. If at last there are no colored residues to be seen, dab the spot with grain alcohol.
Fat	Usually a bit of detergent or hot, soapy water and a machine wash are all that is needed. An old home remedy is potato starch, with which the fat is first absorbed, then brushed out. As an alternative, alcohol or spirit of soap are also effective.
Spinach	Rub a raw potato over the spinach stain, then wash it with soapy water.
Ballpoint pen	This problem requires time, some alcohol, white spirits or lemon juice. When you clean your clothing later as usual, the stain should be gone.
Blood	If you see blood, perform first aid as follows: wash immediately with cold water, then soak in saltwater. For old stains – it is helpful before washing to apply some dilute ammonia – regardless of blood group.

Stain removal using home remedies was excerpted with the kind permission of Peter Eberhardt from the "Fleckenlexikon" ("lexicon of stains") at www.ludwika-eberhardt.de/fleckenlexikon.htm

Bleach as a part of daily life

Another social obligation in a fine restaurant. Delicious roast duck on your fork, more in fact that the fine motor skills of your hand can cope with and suddenly … oops ... it happens. Your exquisitely white shirt now bears a large, fatty brown stain. Time for some bleach. This is what we know from the daily bombardment of television advertisement.

HOWEVER, what is often unknown is the fact that in many other areas of daily life, bleach plays an equally relevant role for us all.

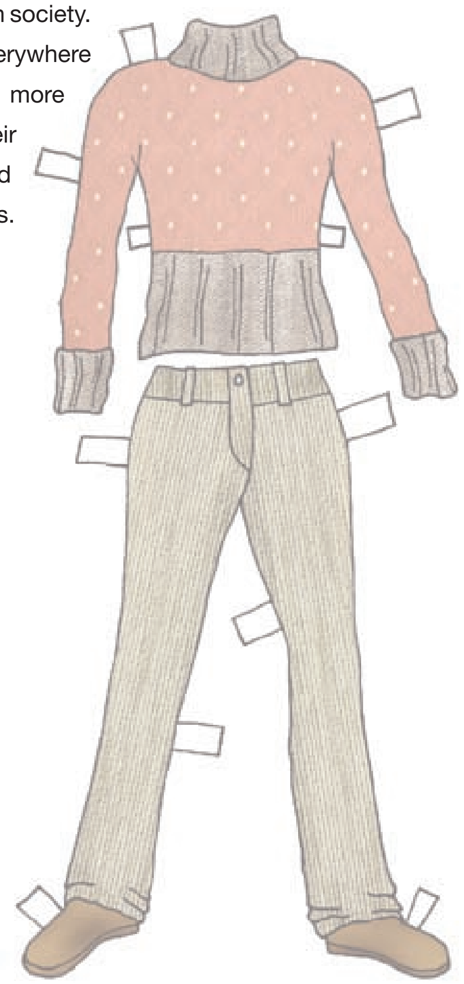
In traffic for example. We vaguely remember a rather fast drive under time pressure to a customer meeting two weeks ago. Something happened, didn't it? Wasn't there a flash? Today is a good day. Saturday. We walk to the mailbox, get the morning paper and have a look at the mail with the speeding ticket. **BLEACH WAS INVOLVED!**

School is another example. Just yesterday with fervent inspiration we made it clear once and for all to the puffed-up parents of the kid at the head of the class that our child is better in every aspect of school performance than their pale little sissy. Today we received a summons from the teacher to a "crisis discussion". **BLEACH PLAYED A ROLE HERE.**

The dentist's invoice is another example. Who remembers their last long session with the dentist with any pleasure? The pale face of the dentist while removing the ancient bridge and the disgusted sighs of his assistant under the mask as she looked as the rotten tooth stumps. Not much fun. Forget about it. Don't think about it any more. And then the message comes from the health insurance company. No coverage for that treatment and – once again, **BLEACH IS PART OF THIS!**

As one can see from the examples above, bleach represents not only a chemical phenomenon but also a sociological one seldom recognized in many areas of our modern information society. Bleaches are everywhere and deserve much more attention for their often damaging and destabilizing effects.

+rh



Natural fibers

2009 is the International Year of Natural Fibers (www.baumwollboerse.de), intended to remind us of the importance of these raw materials. Since the Stone Age, man has used natural fibers to produce clothes, jewelry and tools. Stone were held in place with fibers, bows were spanned to use with arrows during the hunt. Ropes, sails and other items were made from plant fibers.

Plant fibers are subdivided into:

· bast fibers of stems (such as jute, hemp, cambric grass fiber, flax, kenaf, phloem)
· leaf fibers (such as various palms)
· seed fibers (such as cotton)
· fruit fibers (such as Java cotton)
· other fruit fibers (such as coconut)

Another classification criterion is processing characteristics. A distinction is made between hard and soft fibers. Hard fibers include sisal and coconut fibers. Soft fibers include cotton, hemp, flax and jute.

Today, cotton constitutes the bulk of fiber production. In Europe, it replaced hemp on the market. Hemp, which is better known today for the intoxicating effect of its ingredient THC, was used earlier for the manufacture of clothing, ropes for agriculture, ropes and sails for maritime use, household equipment and much more.

Cotton as a typical example

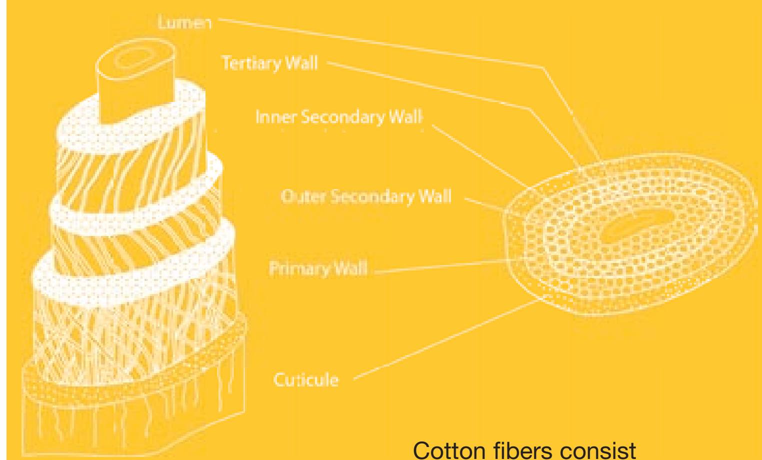
Cotton (German: Baumwolle, French: Cotonier, Spanish: Algodón) is the seed fiber of the mallow-like cotton plant Gossypium l. Today the originally perennial bush is grown nearly everywhere as an annual (self-pollinating) plant. After sowing it requires a lot of water and later lots of warmth.

Therefore the main regions in which it is grown lie between the 36th and 43rd parallel.

After flowering, the fruit nodes of the bush burst open and the seed fibers swell out. The seed fibers themselves are on the seeds contained in the boll. Each boll contains about 30 seeds, each of which has about 2,000 to 7,000 seed fibers.

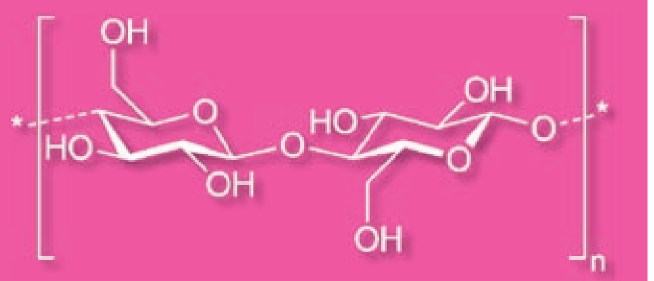
The structure of cotton fiber

A cotton fiber is made of various layers. In the interior is a hollow space filled with air, the lumen. This serves as a reservoir for water. The lumen is surrounded by the tertiary wall. It consists primarily of impurities and functions as the "filter" for the fiber. The next layers are the inner and outer secondary wall, which consist almost entirely of cellulose and influence the stability of the fiber. The secondary walls are enclosed by the primary wall. The primary wall consists of a loose layer of cellulose which can store moisture. The fibers are protected by the cuticle, a water-repellent layer of wax, fats, hemicellulose and pectins.



Cotton fibers consist of about 91 % cellulose, 7.85 % water, 0.56 % protopectins, protoplasts and 0.20 % mineral salts.

The ripe fibers have a characteristic twist which makes it possible to spin the cotton. The twist is produced by the layered, arrangement of cellulose in alternating directions:



Cellulose consists of β-1,4 bonded glucose units. They form unbranched chains which are insoluble in water. Hydrogen bridges between the individual chains lead to the parallel arrangement of chains in the plant fibers. Cellulose is the most common and most widely distributed biopolymer. It is the most important raw material for the pulp, paper and textile industries.

Properties - look what cotton can do!

Cotton is not just a comfortably soft, light material; it is also very sturdy: it is tear-resistant, resistant to abrasion and insensitive to acidic and basic fluids. Cotton is permeable to air, is not insulating and transfers excess heat outward. The fibers can hold large quantities of water, about four times their weight, without feeling wet.

Many of cotton's properties were recognized very early as being advantageous to humans. We wear it against our skin in underwear, T-shirts, jeans, shirts and blouses. Wounds are staunched with cotton wool, and hygiene products are made mostly of cotton wool.

For sportsmen, however, the absorbent properties of cotton are disadvantageous, because a sweat-soaked shirt takes a long time to dry. Thus sportsmen now generally prefer synthetics. +as

Synthetic fibers – all chemistry

For thousands of years, man has used clothing as protection against the influences of the environment. While clothing used to consist entirely of natural materials long ago and served basic needs such as protection from cold weather, in the past 100 years a lot has happened in this area due to the spreading use of chemical fibers. On one hand, there area large number of chemical fibers whose properties are very similar to those of natural fibers and therefore are used as replacements or in mixtures with them. On the other hand, in recent decades a number of chemical fibers have been developed with properties considerably different from natural fibers. These have opened up new areas of use for the textile and clothing industry. Today, such chemical fibers are contained in a large variety of clothing; examples can be seen in our reports on sports or protective clothing. This article now offers a brief overview from a chemist's perspective of some of the most important artificial fibers.

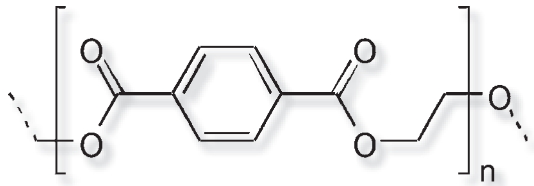
Polycondensation fibers

Polycondensation fibers are polymers produced by polycondensation reactions – i.e. generally by splitting off simple molecules (such as water) from monomers. As with normal condensation reactions, the functional groups created are frequently acid derivatives such as esters and amides.

Polyesters (PES) and polycarbonates (PC)

Polyesters have ester groups R^1-CO-O-R^2 in their structure. Along with these polymer fibers derived from carboxylic acids, there is also the special case of the polycarbonates, the corresponding polyesters of the carbonic acid with the functional group R^1-O-CO-O-R^2.

Polyethylene terephthalate is among the most important examples of these fibers. It is synthesized from terephthalic acid and ethylene glycol and is used in the textile industry for nonwoven materials and fleece.

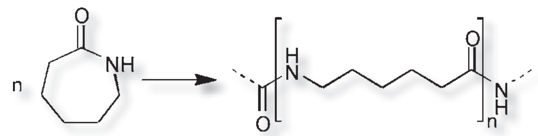


Polyethylene terephthalate (PET)
empirical formula: $(C_{10}H_8O_4)_n$ / CAS RN: 25038-59-9

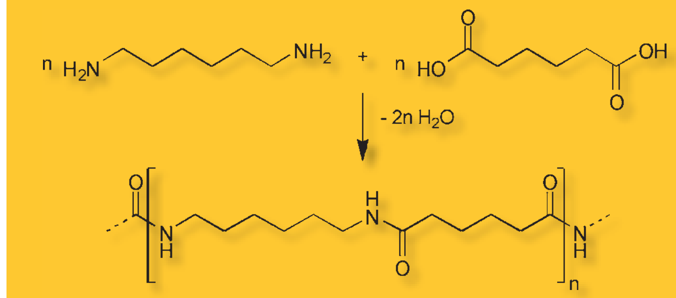
Polyamides (PA)

Polyamides are formally polycondensation products of amines and carboxylic acids and contain the amide group R^1-CO-NH-R^2 in their repeating unit. The systematic designation of these polymers is derived from the monomers. Thus polyamides made from an amino-carboxylic acid or a corresponding lactam are designated as PA x, where x is the number of carbon atoms in the monomer. Condensation polymers made from a diamine and a dicarboxylic acid are designated PA xy, where x is the number of carbon atoms in the diamine and y the number of carbon atoms in the dicarboxylic acid.

Among the best known examples are PA 6, synthesized from ε-caprolactam and known by the trade name Perlon, and PA 66, made from adipic acid and hexamethylene diamine and often sold under the designation Nylon. Both fibers are very similar in properties and thus also applications. They are used, for example, in making women's stockings and parachutes.

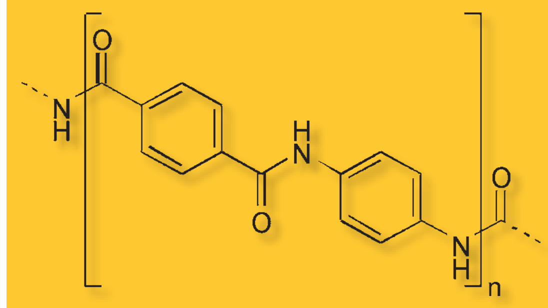


Perlon (PA 6) / empirical formula: $(C_6H_{11}NO)_n$ /
CAS RN: 25038-54-4



Nylon (PA 66) / empirical formula: $(C_{12}H_{22}N_2O_2)_n$ /
CAS RN: 32131-17-2

The aramides assume a special position among polyamides. They are characterized by aromatic groups in the main chain of the polymer. Aramides generally exhibit high strength and heat resistance and are used accordingly for protective clothing, for example under the trade name Kevlar for bullet-resistant vests as reported in detail elsewhere in this issue.



Kevlar (aramide) / empirical formula: $(C_{14}H_{10}N_2O_2)_n$ /
CAS RN: 24938-64-5

Polymerization fibers

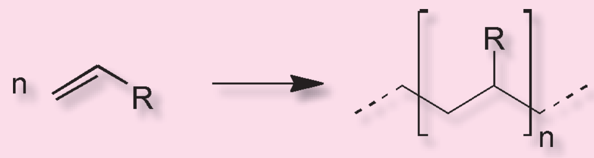
Polymerization fibers are polymer fibers formed during polymerization, generally of unsaturated monomers, during the transformation involving multiple bonding.

Polyacrylonitrile (PAN), polypropylene (PP) and polyvinyl chloride (PVC)

Polyacrylonitrile is used as a main component (> 85 % fraction) in copolymer fibers with trade names such as Dralon or Orlon. These fibers are very similar to the natural fiber wool and are used accordingly, often as a mixture with wool, for products such as sweaters and blankets as well as imitation fur.

Polypropylene is distinguished by low permeability to water vapor. It is frequently used in the textile industry as a combed yarn and for products such as sports clothing, underwear and carpets.

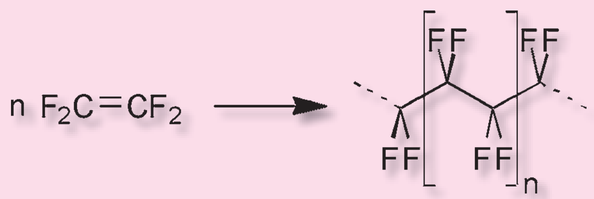
Polyvinyl chloride is known to many as PVC for floor coverings, but it is also used in the field of textiles for artificial leather for example. Its high water resistance – and comparatively low cost – make it popular for jackets, coats, smocks and handbags. It is also widespread in fetish and subculture scene clothing (SM, techno, rave, gothic, punk, etc.).



Polyacrylonitrile (PAN; R = CN) / empirical formula: $(C_3H_3N)_n$ / CAS RN: 25014-41-9
Polypropylene (PP; R = CH3) / empirical formula: $(C_3H_6)_n$ / CAS RN: 9003-07-0
Polyvinyl chloride (PVC; R = Cl) / empirical formula: $(C_2H_3Cl)_n$ / CAS RN: 9002-86-2

Polytetrafluoroethylene (PTFE)

Polytetrafluoroethylene is a very inert, heat-resistant polymer with a low coefficient of friction. It is known to most people by its trade name Teflon and is used among other things as an anti-stick coating for pots and pans. In the textile industry, it is known by another trade name – Gore-Tex. Here PTFE is processed as microporous membranes which are permeable to water vapor and thus "breathe" particularly well but at the same time are waterproof. These characteristics make Gore-Tex especially popular for making outerwear and shoes.



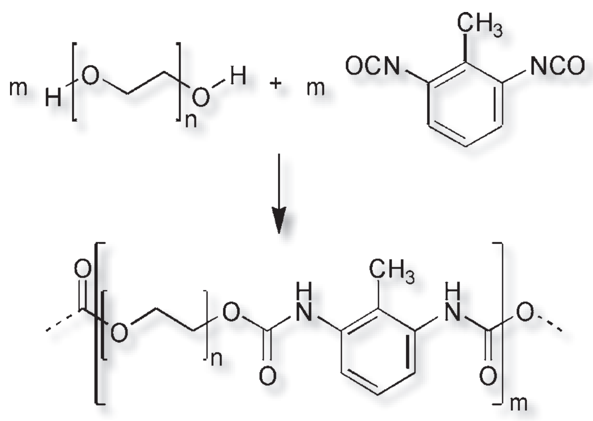
Polytetrafluorethylene (PTFE) / empirical formula: $(C_2F_4)_n$ / CAS RN: 9002-84-0

Polyaddition fibers

Polyaddition fibers are produced by addition reactions of the corresponding monomers. For example, polyurethanes are produced by the addition of alcohols to isocyanates.

Polyurethanes (PU)

The majority of polyurethanes are synthesized from aromatic isocyanates – such as 2,4- and 2,6-diisocyanatotoluene – and polyethers as diol components. In the textile sector, for example, it is processed as a copolymer with polyethylene glycol under the trade names Elastane and Spandex (polyurethane fraction ≥ 85 %). Elastane is extremely elastic and is therefore used especially for clothing which must have high elasticity and fit closely, such as sportswear and swimsuits. It is usually used as a mixture with other fibers.



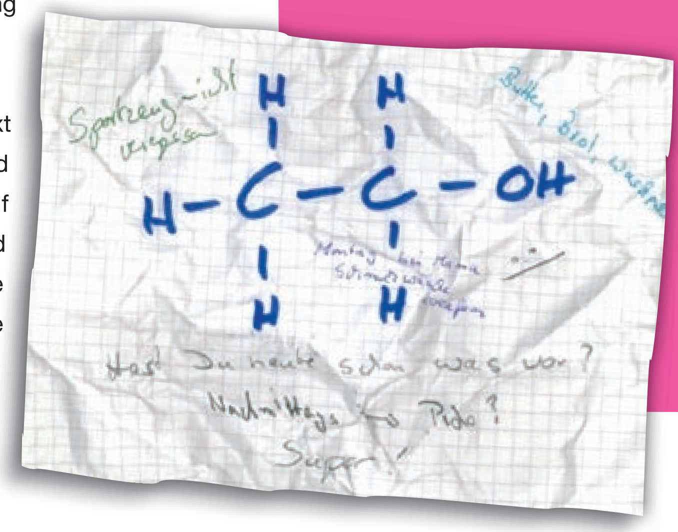
Polyurethane such as in Elastane and Spandex /
CAS RN: 308076-05-3

The CAS registry number® (CAS RN) is a trademark of the American Chemical Society. +roe

Interpretation of the structure of alcohol

An early work (see above) of a now world famous contemporary but nearly forgotten artist was auctioned recently in London and immediately drew my attention. Dear readers, I would like to elaborate a bit on the matter which concerns me, with a wink of the eye. …

Striking the eye, the almost liturgical simplicity and elegance of the line marking in the central dominance of the structural formula prevailing throughout the work of the 44-year-old artist reveals itself to the astonished observer in the first moment of the viewing ritual; its hopeful blue embodies a parable of austere elegance against the wrinkled abyss of the rigorously geometrical phalanx of boxes, reflecting the accompanying puritanical severity.



The destructivistic karma of the text fragments broken into phrases and nearly illuminating the central motif creates a mystical clarity of morbid simplicity for the causality of the spiritual disengagement from the here and now expressed by the strict formalization.

The detachment and convergent simplicity of the melody of the line drawing do not lack irony, indeed a certain narcissism. The artist interweaves impressions of a better world with an enlightened acceptance of a traditional social order which guides the viewer with to-do items such as laundry, sports gear or bread to the roots of his reason. Cubist parallels of the path of life and the meaning of the artwork are an expression of a synergistic amalgamation of foreground and background, from which the pure alcohol – spirito claritatis – shines as a sort of deus ex machina in depressing clarity as a warning. +rh

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