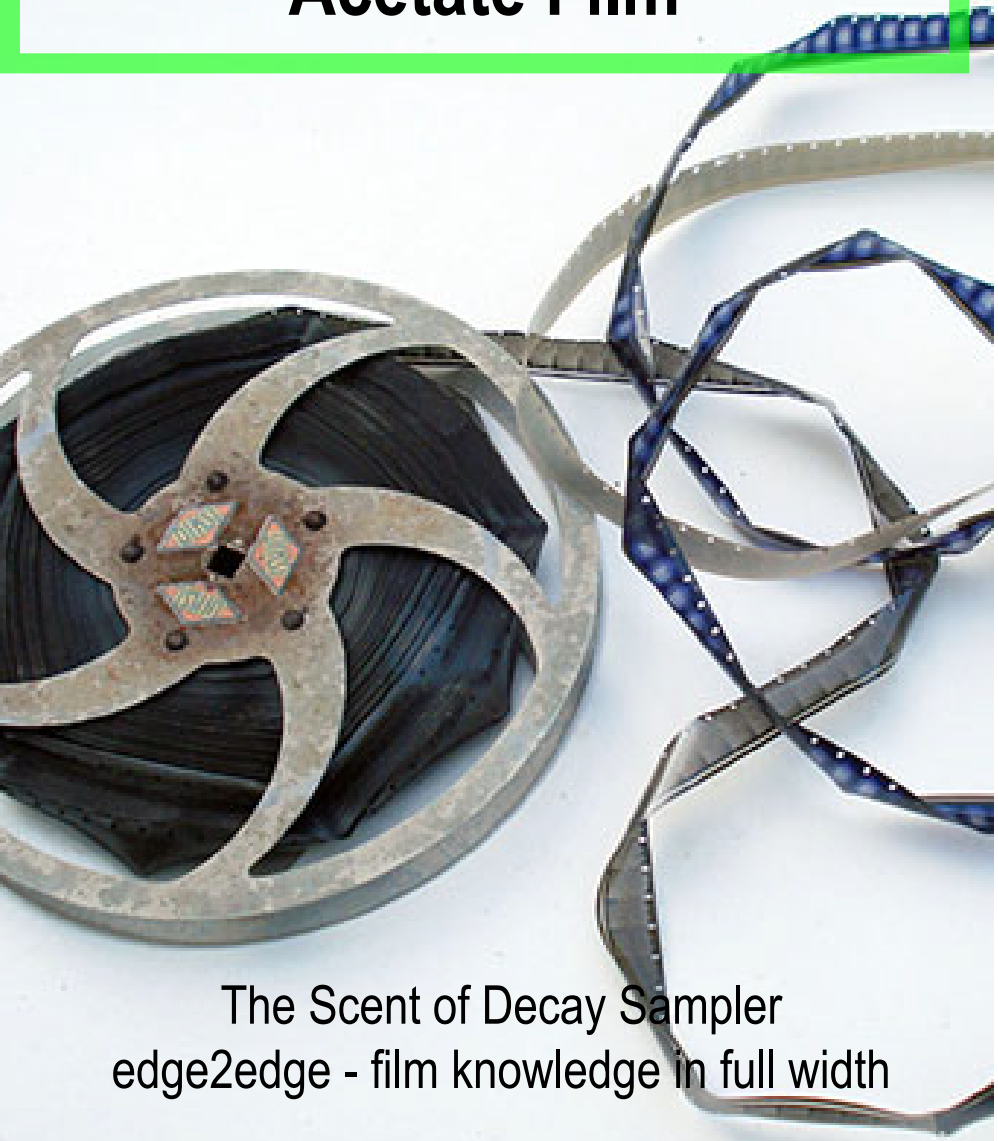
1. Decaying Cellulose Acetate Film



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edge2edge - film knowledge in full width

Acetate film is also known as "Safety Film". Since the 1940s its plastic base is made of cellulose triacetate but cellulose diacetate was used as a film base in the first half of the 20th century as well. Other cellulose derivatives existed but played a comparably minor role. Cellulose acetate‘s low flammability made it an ideal replacement for the highly flammable nitrate film. Thus the name "Safety Film". Cellulose triacetate is an ester of cellulose which is synthesised using acetic acid. In the presence of humidity the process is reversed and the polymer chains of the plastic are broken down while releasing acetic acid. The process is autocathalytic which means that it starts slowly but after a certain point will increase at an exponential speed. The smell of acetic acid on a film reel announces the onset of the exponential part of the decay. A film reel in active decay can trigger the process in other reels by the acetic acid it releases. The odour of acetic acid is reminiscent of vinegar and therefore the decay of cellulose acetate is called the "vienagar syndrome".

Apart of dye fading the vinegar syndrome is the number one threat to our film heritage.

Triphenyl phosphate is used as a plasticiser for cellulose triactetate plastic today. Historically various plasticisers like monochloronaphthalene were used.

2. Decaying Cellulose Nitrate Film

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The plastic base of nitrate film is a combination of cellulose nitrate with up tp 30% of the platiciser camphor. The completey transparent material "celluloid" was one of the first plastics. It was developed in the mid 19th century and found one of many applications as base material for flexible photographic film.

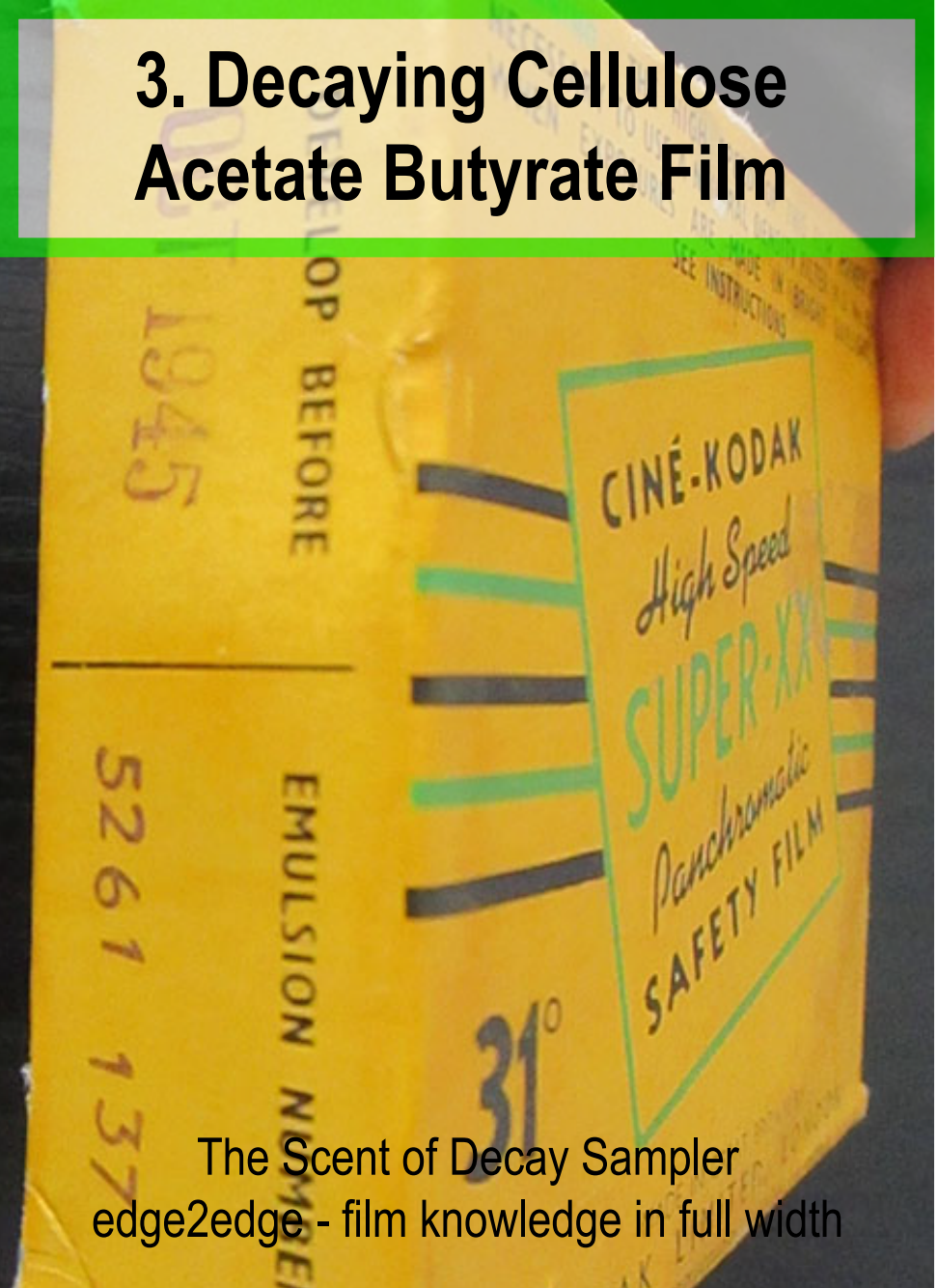
Cellulose nitrate is highly flammable and has been responsible for several devastating fires. Apart from being almost inextinguishable, a nitrate fire also produces toxic gases. Celluloid became notorious for this reason and alternatives had to be found. Cellulose acetates and other cellulose derivatives were viable choices. By the mid 20th century nitrate film has been entirely replaced by cellulose triacetate. Films from the first half of the 20th century with bases made of cellulose nitrate and its early replacements like cellulose diacetate, cellulose acetate butyrate and other compounds can still be found in archives.

Cellulose nitrate is an esther of cellulose and nitric acid. Equivalent to cellulose acetates, the process is reversible in the presence of water. The hydolysis of celluloid produces nitric acid. The strong acid causes significant damage to other components of the film: The gelatin layer becomes sticky and the image comprised „melts away“. The silver contained is oxidised to transparent silver nitrate.

Camphor the plasticiser used in celluloid is a transparent solid with a strong recognisable scent. In spite of that celluloid is odourless.

Nitrate film cannot be included in this set for safety reasons. The odour sample of decaying nitrate film has lost it flammability through chemical decay.

3. Decaying Cellulose Acetate Butyrate Film



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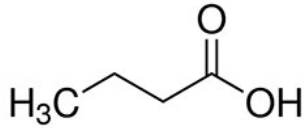
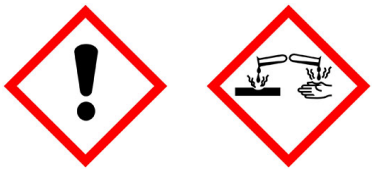
Cellulose Acetate Butyrate is a cellulose derivative similar to cellulose acetates and cellulose nitrate which were more frequently used as film base. In the synthesis process butyric acid is used. Butyric acid has a particularly pungent smell of vomit. The smell is so strong and repulsive that access is very limited and a sample of butyric acid cannot be included in this set for reference. In the decay process of cellulose acetate butyrate the acid is released and identifies in a straight forward manner the make-up of the film base. Cellulose acetate butyrate is slightly tougher than cellulose actetates but identically transparent. They can barely be told apart except through spectral or chemical analysis.

Cellulose Acetate Butyrate was only briefly used as film base, probably from the 1940s to the early 1950s and probably just for 16mm film.

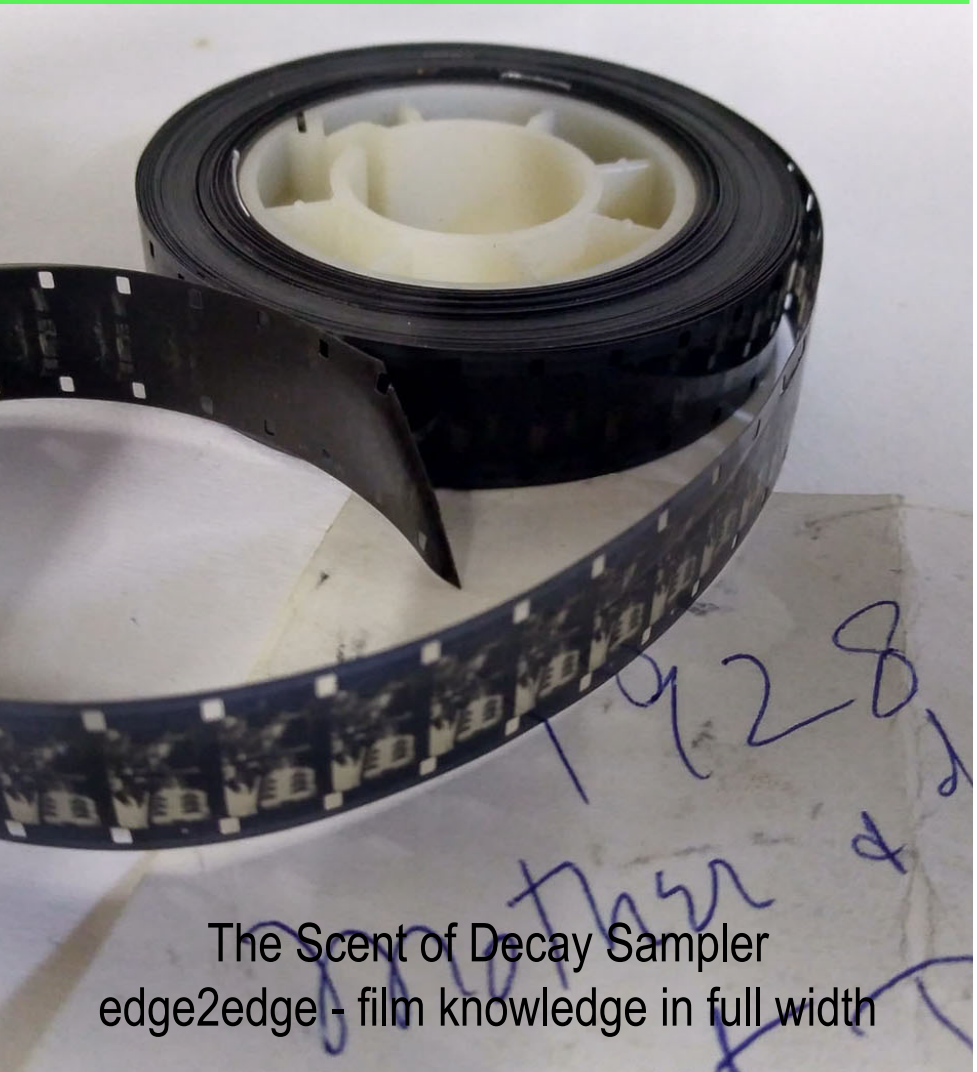
Butyric acid is not particularly toxic but regular exposure should be abvoided.



Butyric acid



4. Historical Cellulose Acetate Film



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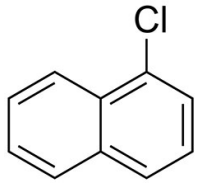
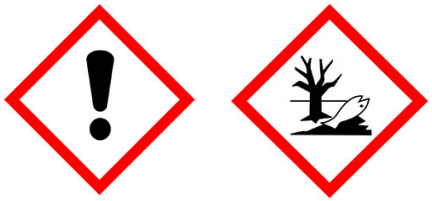
While nitrate film was used for 35mm film up to 1950, cellulose acetates have been used primarily for small gauge films for amateurs since the 1910s. "Old Film" has a particular smell even if the base is not affected by significant hydrolysis. The socalled Natphthelene-Syndrome is an odour of naphthalene which can be traced back to chloronaphthalenes. They were used as plasticisers for cellulose acetate plastics before triphenyl phosphate.

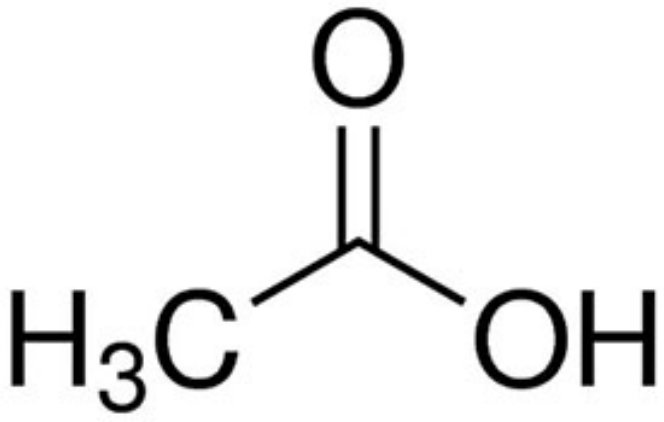
Chloronaphthalenes are irritant and fairly toxic and cannot be included in this set as a reference substance. The sample of old film included in this set exhibits an odour which is dominated by chloronaphthalene but it is the result of various other subtances included in ageing film.



1-Chloronaphthalene



5. Reference sample: Acetic Acid (5% in Water)



Acetic acid is an organic acid which is easily identified through its typical odour. The odour is known very well through vinegar which consists mainly of acetic acid and water. Acetic acid is not particularly toxic but it is irritant and corrosive nontheless.

The human sensitivity to the odour is very high which in priciple makes our nose an excellent detector for the vinegar syndrome in acetate film. However, because of its irritant nature the exposure to acetic acid on a regular basis should be avoided.

Film archives should not rely on their staff‘s noses to detect the vinegar syndrome. So-called AD-strips issued by the Image Permanence Institute are available to measure the presence of acetic acid in acetate films. A colour code helps to judge the severity a reel is affected.

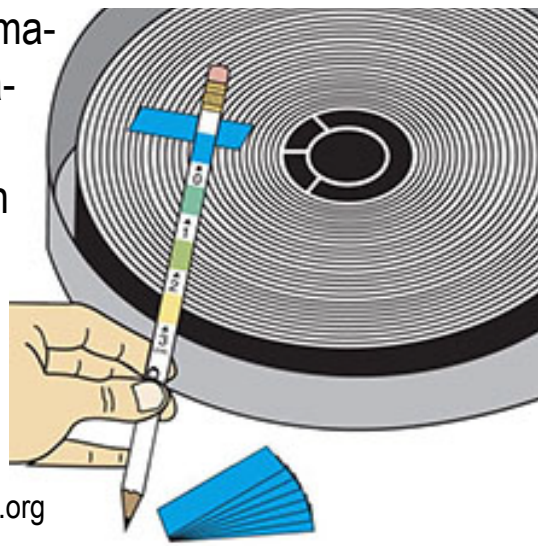
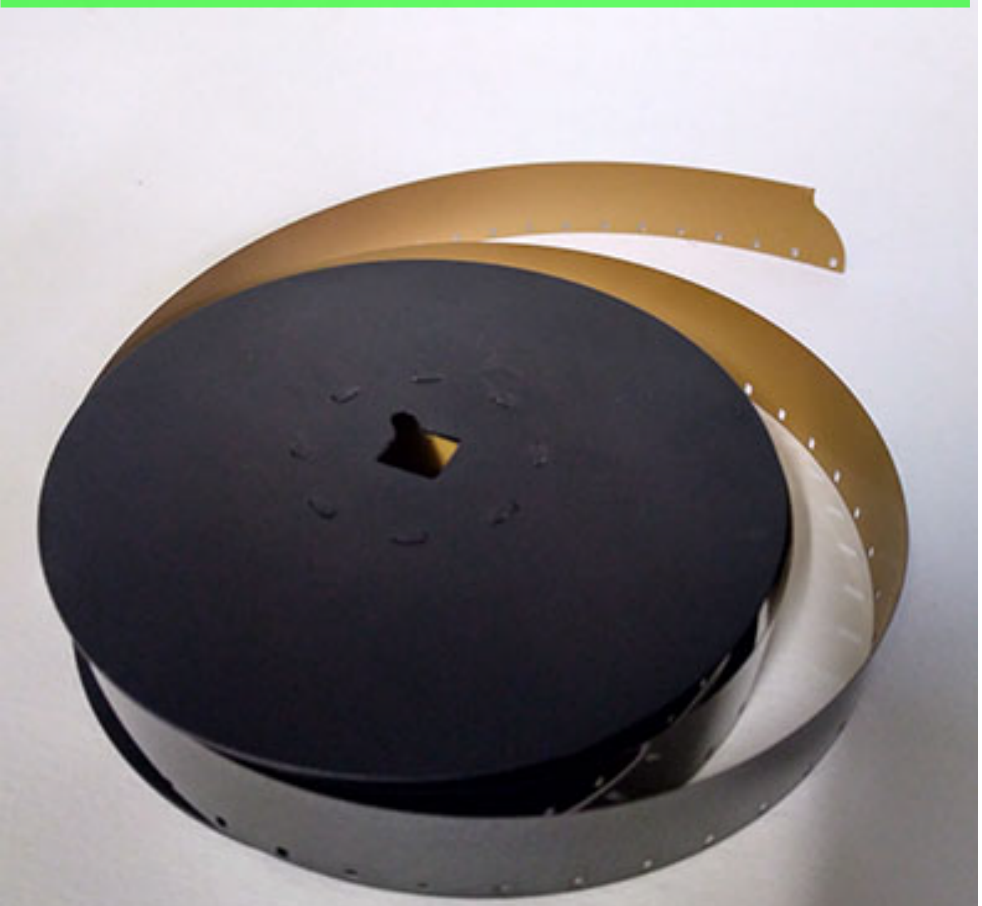


Image by filmcare.org

6. Reference sample:
Plasticiser Triphenyl Phosphate

Triphenyl phosphate is a common plasticiser for cellulose actetate plastics. Cellulose triacetate contains 12-15% of triphenyl phosphate which also acts as flame retardant. It has replaced monochloronaphthalene which was used with cellulose diacetate. Triphenyl phosphate is practically odourless, so is the combined product, the triacetate film base. Any odour coming from a "healthy" acetate film comes from chemicals present in the photographic layers. Triphenyl Phosphate's presence in decaying acetate film can be expected to contribute only marginally to the odour. Largely chemically unaffected by the breakdown of the cellulose acetate it tends to cristallise on the surface of the film. Triphenyl phosphate is moderately toxic to humans but more dangerous aquatic environments.

7. Reference sample:
Unprocessed Motion Picture Film



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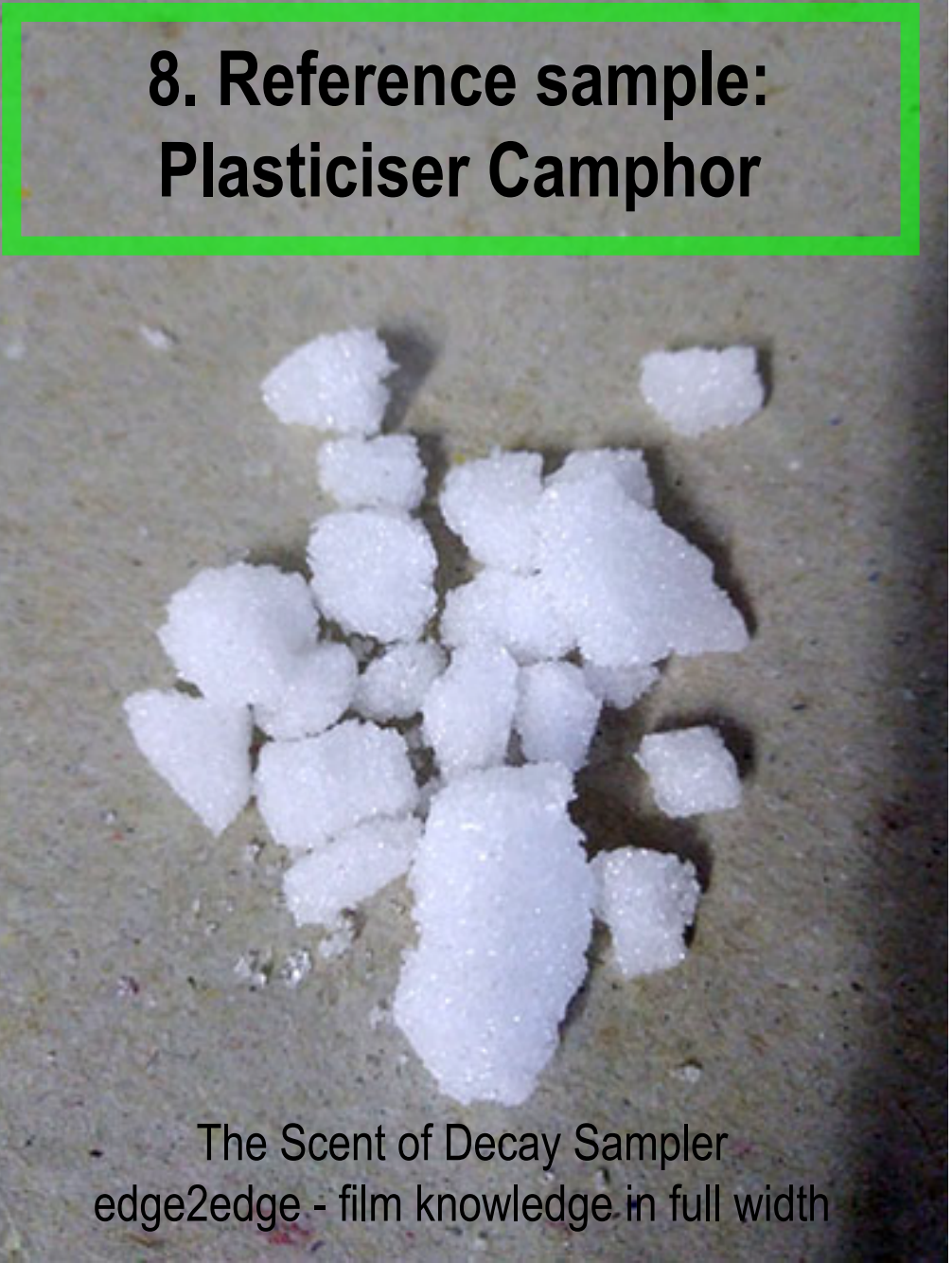
The main volumetric component of a motion picture film is the plastic base consisting of the polymer and a plasticiser. An exception is the polyester film base, which does not contain a plasticiser.

Various layers are applied to the base in the production process of film materials containing a myriad of chemical compounds. In the development process after exposure, a significant part of these compounds are chemically altered and/or washed away. Accordingly a non processed film has a particular odour which is usually lost after processing.

The odours of various film materials are different and cannot easily be allocated to one particular family of agents. The sample included can just give an idea of the type of scent unprocessed films have.

8. Reference sample: Plasticiser Camphor



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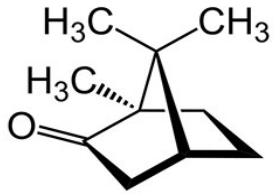
Camphor, the plasticiser used in celluloid, is a transparent solid with a strong recognisable scent. It is a natural product, extracted from the camphor laurel. It has a quite pleasing odour but nevertheless its toxicity should not be underesti-mated.

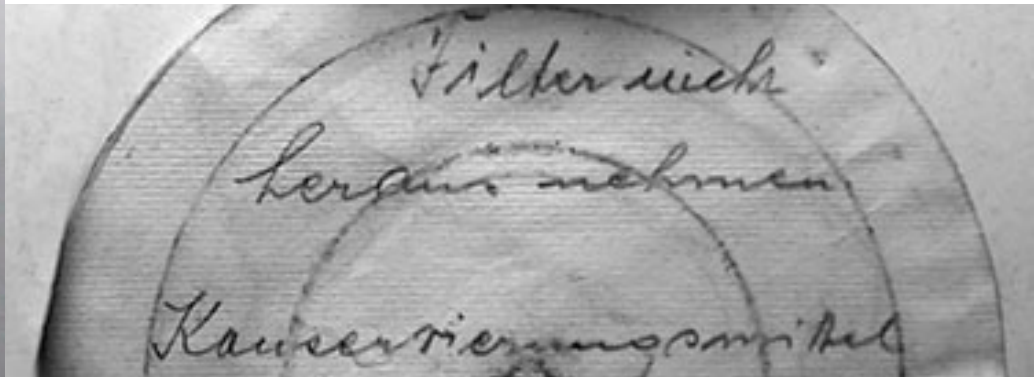
In spite of up to 30% of camphor being contained in celluloid, the plastic is odourless. Ageing celluloid in course of decay may exhibit an odour of camphor due to camphor coming out of the plastic. However a film may also pick up the odour due to the application in the past of a film preservative containing camphor.



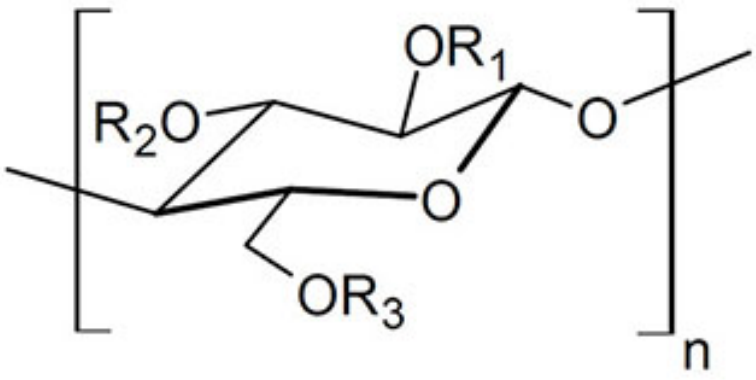
9. Historical Film Peservative

Various compounds go under the term "film preservative". The sample contained in this collection is from the 1960s. The liquid is intended to be applied onto a blotting paper which is then stored in the film can together with the film. The aim was that substances gassed out from the film preservative would keep the film smooth and flexible.

As camphor was a part of celluloid acting as plastifier it is comprehensible that it was assumed that adding camphor to a preserving agent would be of advantage. If this is actually the case or if the effect is on a measurable scale remains unknown. A positive influence of camphor on other cellulose derivatives is very questionable, still it was used for all types of films. Some film preservative recipes also contain glycerol as well as essential oils like eucaliptus or mint oil. A positive effect is not scientifically documented.



10. Reference sample: Cellulose Acetate Butyrate



R_1, R_2, R_3, = Acetyl, Butyryl, or H

Cellulose Acetate Butyrate is a cellulose derivative. In the synthesis process butyric acid is used which has a particularly pungent smell of vomit. The odour is so strong and repulsive that access to the compound is limited and a sample of butyric acid cannot be included in this set for reference.

Cellulose acetate butyrate is widely used as a plastic. It serves for the production of items like tool handles, car parts and blister packaging. It is also a component used in paints and adhesives. The odd smell of some old screwdriver handles is due to cellulose acetate butyrate in the process of slow hydrolysis.

The sample contained in this series contains the plastic in powder form. Due to it being a fine powder the typical butyric acid smell can be slightly perceived.

Cellulose cetate butyrate is not toxic but repeated inhalation in the form of dust should be avoided.

Mold
No sample included

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Mold has a very particular musty smell which probably everyone has experienced at some point. As it comes from a living entity a certain biohazard comes with it. The spores of a fungus can pose a threat to the human lung when inhaled and so if there is any suspicion of mold infestation on a film, the reel should be isolated and treated. Inhalation should be avoided.
Due to this fact a sample of film with mold cannot be included in this set.
There are strategies to kill the infestant but the "tracks" it leaves behind cannot be removed.