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Acetate Microfilm

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Many local governments and state agencies now face the problem of deteriorating acetate microfilm because they used film with an acetate base. Since acetate was the most common film base from the mid-1920s into the early 1980s, if your organization holds microfilm produced during this time period it is almost certainly acetate-based. Poor environmental storage conditions, combined with acetate's intrinsic susceptibility to decay, frequently accelerate the film's deterioration. Polyester-based film, used after the early 1980s, does not have the same risks of deterioration as acetate film. The two major risks posed by acetate microfilm, information loss and off-gassing, are correctable, but only planning and quick action will help minimize damage. This publication describes acetate-based film, the problems associated with it, and mitigation strategies.

History of Acetate Microfilm

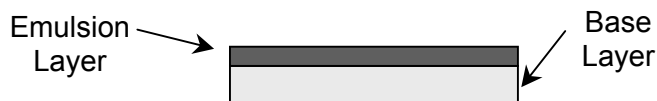
Liverpool optician Benjamin Dancer developed the process for microfilm in 1852, and the process has been employed for various uses up to the present. Early microfilm used a nitrate base, which was very unstable and easily caught fire. As a substitute for flammable nitrate-based stock, film manufacturers developed a "Safety Film" with a cellulose acetate base that was much less flammable.

Companies produced and distributed acetate film between 1923 and 1970, but supplies of cellulose triacetate may have been available until about 1980. It was most widely used from the early 1930s into the 1970s. Apart from microfilm, acetate was also the base for several other types of film media, including professional cinematic productions, amateur still film, x-rays, home movies, audio reel-to-reel, and audiocassettes. However, the composition of acetate film has resulted in complications to the long-term maintenance of this media.

Composition of Acetate Microfilm

Microfilm, like all kinds of photographic film, is composed of layers. While there are several different layers, the base and the emulsion layers are the most important. The base layer is the thickest, providing the film with its rigidity and a foundation for the other parts of the film.

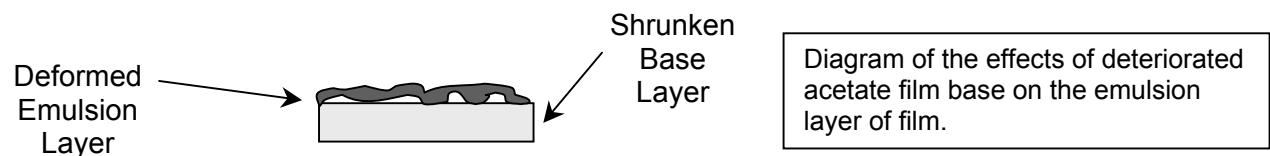
The emulsion layer is the part of the film that actually contains, or holds, the image. This layer is chemically fixed to the base layer during the developing process. Together, these two layers make microfilm a useful and durable media.



Historically, microfilm has been made from one of the following support or base materials: cellulose nitrate, acetate (including cellulose diacetate and cellulose triacetate), or polyester. Acetate is not used in the image creation process and is not present in the image, or emulsion, layer of the film. Therefore, any acetate film problem exists even before filming any images.

Acetate film base is a modified form of cellulose with an inherent tendency to degrade. Chemically, the cellulose acetate composition changes, causing acetyl groups to break from the chemical chain. There are several results of this process.

One result is the formation of acetic acid. The presence of this acid increases the rate of deterioration and emits a vinegar odor. This chemical deterioration also causes the base layer of the film to shrink while the emulsion layer maintains its normal size. In extreme cases of deterioration, warping, curling, buckling, embrittlement, and blisters (also known as channels) appear on the film.



Acetate Film Deterioration and Why It Is a Problem

Film that has deteriorated to the extreme state shown above is unreadable by microfilm devices, and may result in expensive reproduction costs or total information loss. Since many important records are stored on microfilm, preserving the information held on the acetate film is not only vital but may also have legal implications. Therefore, the most significant damage concerning acetate microfilm is not the distortion of the film, but the *loss of information* on the film. Loss of information is obviously a critical concern for organizations that hold the only copy of certain permanent records.

Identifying acetate film that is in a highly degraded state is usually easy. However, microfilm that does not manifest visible signs of deterioration is still at risk. The acetic acid and associated gases released as by-products of the chemical reaction are also a catalyst in the further decay of the film. High temperatures and humidity levels can combine with the acetic acid in the film base, causing an accelerated decay. The presence of these substances can contaminate surrounding material, to the point that they can damage film and other material not originally in danger. This problem can be compounded by tight enclosures, such as boxes, drawers, and cabinets.

Once acetate film reaches the autocatalytic point, the decaying film begins to “feed on itself,” and the rate of decomposition becomes very rapid. The more advanced the deterioration becomes, the more the reaction rate is influenced by the amount of acid present. You can measure the acidity (level of acetic acid) in the film with acid-detection products, as discussed below. Off-gassing, identified by its vinegar scent, emits a gas that can also pose a health hazard to humans when present in high concentrations.

How to Identify Acetate Film

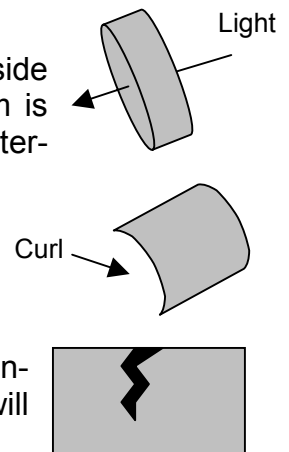
There are several methods to detect acetate-based microfilm in your organization’s holdings. Some of these methods are not relatively accurate, while others offer a higher level of precision.

A good way to begin is by inspecting the date of production. Film produced after 1980 most likely has a polyester base, although some acetate-based film was probably in vendors’ supplies after this date and could have been distributed. Keep in mind that microfilm stored offsite, such as camera negatives, may contain acetate, so be sure to check film in these repositories for signs of deterioration.

Sensory evaluation

These methods, or a combination of them, provide simple and inexpensive ways to identify acetate film.

- *View:* Hold a wound roll of film up to the light and examine the side of the roll. If it is opaque (light does not pass through), the film is likely acetate. If the film is translucent, it is probably a polyester-based film.
- *Curl:* Unwind several inches of film. Acetate film tends to curl across the width of the film.
- *Tear:* Attempt to tear a small portion of the leader that does not include any images across the breadth of the film. Acetate film will tear, while polyester film will not.



- *Smell*: Smell the film for a vinegar scent. Acetic acid is vinegar, so its smell is present when acetate-based film deteriorates.

Scientific evaluation

These methods of evaluation are more accurate than the sensory methods listed above. However, these techniques require that you obtain additional material to conduct the assessment.

- *Polarization Test*: In order to determine whether film is acetate or polyester, place a portion of the suspected acetate film between two sheets of polarizing filter. Polyester film will show color fringes (similar to oil on water) on the sample, but acetate film will not form these color bands.
- *Acid-Detection (A-D) Test Strips*: Use A-D strips to scientifically confirm whether or not film has an acetate base and to what degree acetate film has deteriorated. Begin the process by placing a small indicator strip next to a microfilm roll in an enclosure. After a twenty-four hour period *compare* the indicator strip with the color chart included with the A-D strips to determine the amount of acetic acid present. You can obtain A-D strips from the Image Permanence Institute (IPI) at Rochester Institute of Technology, 70 Lomb Memorial Drive, Rochester, NY 14623-5604; phone (716) 475-2736; fax (716) 475-7052.

Mitigation Strategies

Determining the level of deterioration is vital when deciding upon a mitigation strategy. There are immediate measures that will slow decay, but implementing a long-term strategy is also important.

Immediate measures

To retard deterioration, separate microfilm by base type. Segregate acetate film from polyester-based microfilm and all other material. You may be able to slow the rate of film deterioration for hundreds of years if you store the film in a cool (below 72°F, 21°C), or cold (below 50°F, 10°C) environment, with moderate relative humidity (20% to 50%). But it is important to remember that these are only stopgap measures and will not resolve the problem; they will only slow deterioration towards the autocatalytic point and prolong usability. For microfilm with a limited retention, this may be a cost-effective alternative.

Long-term strategies

Refilming: If the original paper records are still available, simply refilming them from the paper documents onto a polyester-based film is probably the most cost-effective

method of addressing the problem. However, in many instances, organizations destroyed the original documents after producing the microfilm.

Therefore, duplication is usually the most realistic long-term solution to an acetate film problem. If the film has not decayed significantly, running it through a microfilm duplicator is a possibility. To ensure the best quality, you should use the original silver negatives. You should not duplicate severely deteriorated microfilm using a duplicator. Also, don't view film in this condition on a microfilm reader, since doing so will damage the film. If the curl on the microfilm has advanced considerably, you won't be able to duplicate it using most film duplicators. But if the emulsion is still securely attached to the base, there are a few special duplicators that can solve this problem by pressing the curled master film firmly against new silver duplicate film. The pressure and direct contact of the old film on the new allows for the accurate duplication of the original acetate roll. When considering the duplication of a roll of old acetate microfilm, however, keep in mind that the roll may have other problems (excessive number of splices, weak splices, or poor density or resolution) that make duplication difficult or impossible.

Imaging: Advances in technology are producing additional options in the area of duplication. If the original paper documents are available, producing electronic copies by scanning these is a good solution. If your original acetate film is still in good condition, you can use an electronic film scanner to create digital images from a roll of microfilm. No matter which of these options you choose, you can use the digital images as your use copy and have a service bureau copy those images directly onto silver halide microfilm for long-term storage.

Removing emulsion: A professional conservation lab can remove the emulsion layer from the deteriorating acetate base and place the image on a new, stable polyester base. This method is prohibitively expensive for most organizations, but can be a viable solution for single items of extreme value.

What You Can Do Now

The loss of information, health risks, and possibilities for damage to other records are all acute results of acetate microfilm deterioration. To minimize these risks, you should proceed without delay by following these steps.

1. Identify the quantity of acetate-based film in your holdings.
2. Assess the level of deterioration and the extent of any damage.
3. Control the storage environment.
4. Segregate acetate-based material from other material.
5. Decide on an immediate remedy and a long-term strategy.
6. Conduct periodic surveys of your microfilm.

For More Information and Assistance

The State Archives provides direct advice to state agencies and local governments regarding microfilm and acetate microfilm mitigation. The Archives has regional offices throughout the state, and each office has an expert records specialist who can visit you and provide technical advice and assistance. Archives services also include publications and workshops on a wide variety of records management topics. For further information, contact either your regional office or:

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