CASING SOLUTION

THE INSIDE TRACK 9

MINDING SHRUNKEN FILM ELEMENTS

Question: Does all film material shrink and if so, how does one assess the degree of shrinkage? What causes it to shrink and how can it be minimized. Is shrinkage reversible? Does shrinkage matter when handling, printing or transferring films? Are there other phenomena that look like shrunken film?

The composition of film

Film consists of a support or base, a gelatine-based emulsion, and a binder that holds the emulsion on the film base. The film base is the element that is most likely to shrink. This weakens the bond between the film base and the emulsion layer that it supports. In addition, it forces the emulsion layer to occupy less space, hence the emulsion layer cannot remain flat and therefore wrinkles, causing some loss of information.

Why film shrinks

Shrinkage of cellulose triacetate (CTA) film base results from the evaporation of water or acetic acid from it. Or the plasticizer may have evaporated or crystallized to its surface leaving it sticky with a semi-liquid deposit. CTA is the most frequently used film base for motion picture camera film, intermediate and print stocks. The loss of plasticizer is first evident when the film becomes limp. In a later stage of decay it turns brittle and dry. The loss of water from the film base also leaves it brittle. Because film emulsion includes water as well, it can also dry out. It is evidenced by brittleness and crazing of the emulsion. Although storage in ventilated containers is desirable in order to avoid the build-up of acetic acid vapors, excessive ventilation will encourage triacetate film base shrinkage, and at its limits will reduce the support space available for the emulsion, causing it to wrinkle up, a condition for which we have no restoration solution.

Some film base materials don't shrink

Kodachrome, first introduced in 1936, was based on cellulose butyrate that often included acetate as well. It rarely suffers acetic acid loss, but it shrinks and becomes brittle as it ages. During the last decade, polyester film base has also been used for motion picture film, but only for sound negatives, intermediate and print film stocks, not for camera films. It has been used for magnetic sound film since the 1970s and for microfilm since the 1950s. Polyester (PET) film base materials do not shrink significantly, although the emulsion can expand or shrink depending on the relative humidity in which it is kept.

Some agents accelerate film base shrinkage

(1) To save space and keep film elements together, some archivists may have chosen to store both picture and magnetic sound elements (i.e. final mix, M&E etc) in the same container. The ferric oxide on magnetic sound film causes de-acetylation of its CTA film base at a rate twice that of the CTA picture element, it also contaminates the micro-climate inside the container. It causes a more rapid decay of the picture element, than would have been the case if the picture element and the magnetic sound element were stored separately. These two types of CTA film elements should never be stored in the same container.

(2) Archives frequently store all their film elements in the tin-coated metal cans supplied by the raw print stock vendors. As the film degrades and the concentration of acetic acid vapor inside the metal can increases, it will cause the interior of such cans to rust. This rust accelerates the degradation process significantly. Film elements should never be stored in tin-coated metal cans that were sealed with tape to keep outside air out. Because they are not ventilated either, the gradually increasing concentration of acetic acid vapor during storage, accelerates CTA film base decay due to the so-called 'vinegar syndrome' (de-acetylation). How rapidly the interior of a used metal can will rust in the presence of a small amount of vinegar, may be tested by placing two drops of household grade vinegar inside a closed and otherwise empty metal can. Inspect the interior after a couple of days stored at room temperature and note the spots where rust has already started. CTA film elements must be stored in Archival Grade HD Polypropylene film containers.

(3) Until the recent development and use of Acid Detection litmus paper, archival collections contained both 'fresh' and anonymous and undetected but 'actively degrading' film elements together. Actively degrading CTA materials have a significantly shorter life expectancy than 'fresh' film, with roughly

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1/3 of their life cycle remaining at the point when acidity can be detected. By keeping both in the same vault and storing them both under the same temperature and relative humidity conditions, the ‘fresh’ film elements can be contaminated and find their life expectancy reduced as well, unless the cans and the vault air circulation is vigorous and constantly filtered. Actively degrading CTA film requires, depending on the stage of its degradation, much lower temperature and relative humidity storage conditions,[1] in order to stabilize its condition long enough to permit reproduction without heroic effort or loss of color information.

(4) During the history of motion picture film use, post-processing or after-treatments such as for ‘scratch removal’ (or ‘protection’) have been used, to render film base or emulsion scratches invisible during printing or projection. Such treatments included various types of lacquer or varnish, or UV hardened polymer coatings. The latter are non-removable coatings, that were typically applied to production and printing elements, that sealed the CTA film material. They have been found to accelerate de-acetylation degradation. The use of organic solvents to remove lacquer coatings may also enable the CTA material to breathe. But such removal efforts are risky. Nor can it be assumed that all lacquers can be completely removed or without leaving some non-removable and visible artifacts. In addition, some of these solvents, i.e. perchloroethylene now used for film cleaning, are known to also remove plasticizers from the film base materials as well, although a single or a few passes will not have a significant effect. After cleaning the film must be absolutely dry before storage, a problem that could occur when the machine was designed for 1,1,1, trichloroethane cleaning, in which it dried twice as fast.

(5) Poor splices made on incorrectly aligned splicers, or splices that have dried out can also produce sudden and brief moments of unsteadiness at shot changes or may cause jumps at such transitions between shots. This problem can be inherent in the source material from which a duplicate or print is made and exists when new. It is quite possible that it will look worse when the material ages.

De-shrinkage treatments

Motion picture laboratories frequently use equipment that can handle shrunken film without damaging the perforations of such films during handling and printing. Some printer transport mechanisms have been made to compensate for shrinkage by using adjustable sprockets and claw mechanisms that can match the perforation pitch of a particular roll of shrunken film. Some facilities will also use special and proprietary chemical solutions to pre-condition the shrunken film by suspending the bare strands or loosely wound material prior to printing to a micro-environment of chemical vapor. The composition of the vapor treatment typically includes acetone, glycerol, camphor and water. This treatment can take between several hours in a vacuum tank (a vacuum of 30mm Hg), to days or weeks in a closed metal container at 30 degrees C to a period of months. Specialized services[2] use various and similar treatments to temporarily reverse the shrunken condition of film elements, allowing it to be duplicated. It is not reasonable to expect such treatments to penetrate the entire roll of film equally, hence the benefit may be uneven.

How is film shrinkage measured?

Subjectively, the visually disturbing artifact of film shrinkage is vertical and horizontal unsteadiness, when a film element with a shrinkage history anywhere in its chain, or a copy made from the end result is projected on a screen. The whole picture appears to be dancing around in an almost rhythmic and repeating fashion. A shot taken by a cinematographer who held the camera unsteadily in his/her hand can also be unsteady, but the unsteadiness strokes are larger and not as repeatable as unsteadiness. A film shrinkage meter is a graduated scale, using a set of perforation register pins and a swinging arm with a pin the position of which indicates a % of film shrinkage.[3] Such shrinkage measurement tools are available for each film format. It is quite common that shrinkage is uneven throughout a film element.

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[1] See the Image Permanence Institute, IPI Storage Guide for Acetate Film for information relating to storage conditions for both fresh and degrading CTA film materials; also their Storage Guide for Color Photographic Materials.

[2] The Restoration House Inc. (Belleville, Ont., Canada) Redimension Process is based on various solvents and acetone or camphor and a plasticizer to temporarily treat shrunken films and render it printable again. They also have the Rehumid Process, using a vacuum chamber, to replace the loss of a film’s water content with a ‘less volatile agent’ which appears to be another mixture of acetone, water and oils.

What are the permissible tolerances for film perforation pitch?
The Society of Motion Picture and Television Engineers (SMPTE) publishes Film Perforation Standards for 35mm, 16mm, 65mm and 70mm camera, intermediate and print films. These standards describe the new condition of the material and the permissible degree of unsteadiness during each stage of image handling. Perforation standards: 35mm, BH type SMPTE 93-1998; 35mm, CS-1870 type SMPTE 102-1997; 35mm DH-1870 type SMPTE 237-1998; 35mm, KS type SMPTE 139-1996; 65mm, KS type SMPTE 145-1990; 70mm, perf. 65mm, KS-1870 type SMPTE 119-1999.

There is a Recommended Practice relating to jump and weave for 70, 35 and 16mm film SMPTE RP 105-1995.

In addition there are Test Films for film registration: Film Registration: Regular 8mm SMPTE RP 19-1995; Super 8mm SMPTE RP 32-1995; 16mm RP 20-1995.

Test Films for Projector Alignment are: 16mm RP 82-1995; 35mm RP 40-1995.

For ordering details, see: http://www.smpte.org

Recommended readings on picture unsteadiness and shrinkage:

Karl-Otto Frielinghaus, (Institute for Photograpic and Cinematographic Engineering of the Institute of Technology, Ilmenau, Thuringia, Germany) *New Investigations on Picture Steadiness of Motion Pictures in Projection,* in J SMPTE, January 1968, pp. 34-41. - The concept of frame unsteadiness is explained and established. A device for the voluntary generation of frame unsteadiness of adjustable magnitude has been developed and has been employed for the systematic investigation of picture steadiness. Its action and performance are described. Statistical and psycho-physical evaluations of frame unsteadiness have been effectuated and limit values for its acceptability have been ascertained. Partial causes, such as the effect of motion picture apparatus (cameras, printers, projectors, etc.), that of the film as such, and the sum of all these defects are described. Methods for the statistical evaluation of frame unsteadiness are given and are illustrated by frequency diagrams, average value curves and tables for the magnitude of frame unsteadiness for various film sizes. Basic points for the reliability of these methods are established. Finally, some conclusions are drawn with respect to the possibility of amelioration of frame unsteadiness in cameras, printers and projectors.

R.G. Gilbert, J.C. Norris and H.D. Wood, *Perceptibility of Vertical Unsteadiness in Television Display of Motion Picture Films,*in J SMPTE, August 1973, pp. 654-657. – The perceptibility of vertical unsteadiness in TV presentations was evaluated using still scenes (35mm slides) and moving scenes (16mm motion picture) projected through a telecine chain. Sinusoidal disturbances having peak-to-peak amplitude of 0.1 to 1.0% of the image height, over a frequency range from 1.0 Hz to 15 Hz, were introduced into the televised scenes. Acceptability of the televised image was judged by an audience representing a cross section of Eastman Kodak Co. employees. The results demonstrate that the most critical frequencies are between 3 Hz and 6Hz. At these frequencies, the audience rated image quality acceptable for unsteadiness amplitudes less than 0.2% peak-to-peak for still scenes and less than 0.3% peak-to-peak for moving scenes. It was concluded that jitter frequency between 3Hz and 6 Hz is the most annoying. In general, the audience would accept one-and-a-half times as much jitter at 1 Hz or 12 Hz as was acceptable at 3 Hz to 6 Hz. Moving scenes mask jitter to the extent that the audience will accept nearly twice as much jitter in moving scenes as in still scenes.