EPM
Eastman Park Micrographics, Inc.

A-1671

Use of IMAGELINK Brown Toner to Extend the Life of Microfilm

Introduction

Microscopic Blemishes

Some processed silver gelatin microfilms in storage from two to twenty years have developed microscopically small colored spots or blemishes. The fogged leader at the outside of the roll is most frequently affected by the blemishes, which are generally red or yellow in color and are smaller in size than the image characters (for example, a typewritten letter reduced 20X) on the microfilm. The spot size does not increase, but the spots proliferate on the microfilm and can appear in image areas. A more detailed description of the blemishes and of the techniques used in inspecting microfilm is given in *National Bureau of Standards Handbook 96.*[1]

The spots are caused by local oxidation of imaged silver, resulting in the formation of minute deposits of yellow- or red-colored colloidal silver.[2,3] Possible oxidizing agents entering from outside the roll of microfilm are aerial oxygen, whose action on the film is strongly accelerated by moisture, and atmospheric contaminants, such as hydrogen peroxide, ozone, sulfur dioxide, hydrogen sulfide and nitrogen oxides, all occurring in industrial atmospheres. Assuming your microfilm was processed to established quality control standards, microscopic blemishes (redox) may still occur due to the oxidation of the metallic silver image depending on storage or use conditions.

It is the opinion of image stability experts both within the Eastman Kodak Company and of EPM that the LE-500 designation for properly manufactured, processed and stored silver gelatin microfilms is conservative and may be expected to outlive the designated Life Expectancy of 500 years. It is also, however, recognized that our world is changing. The increasing number of commercial solvents, auto exhausts, ammonia fumes, paint fumes, solvents, heating gases, and deteriorating cardboard and paper are only a few of the many sources of oxidants and peroxides affecting silver. These oxidants and peroxides are believed to be the cause of redox blemishes. Improper storage conditions also accelerate the formation of redox blemishes.

Once the deterioration of the microfilm occurs, it cannot be reversed. Silver film duplication, molecular sieves and IMAGELINK Brown Toner can be used to stabilize the microfilm and extend its useful life under varying storage and use conditions.

Methodology

Molecular Sieves

Molecular sieves or desiccants, are chemical compounds that act as absorbers of water, hydrogen peroxide and other oxidants. These sieves are also used to offset the vinegar syndrome caused by the decomposition of acetate film support[4]. The sieves are available in the following packet formats from a company called Multisorb, with the following part numbers:

Part #	Film	Format	Content
41 ag 43	16 mm	3.5 grams	400 (1 gal)
41 ag 47	35 mm	7.0 grams	200 (1 gal)
41 ag 51	105 mm	12.5 grams	125 (1 gal)

Rule of Thumb: The sieve size is 2% of the weight of the roll of polyester-based film or 4% of acetate-based film.

NOTE: The sieves need to be replaced at some interval, depending on storage conditions. The use of molecular sieves is cited by the American National Standards Institute (ANSI) as another procedure to reduce redox blemishes caused by high humidity conditions and oxidants in the air. For more information or to obtain molecular sieves call Customer Service at Multisorb (1-800-445-9890).

IMAGELINK Brown Toner Treatment

Brown toning is a chemical treatment that changes the film's processed silver-to-silver sulfide which is much more resistant to humidity and oxidants. IMAGELINK Brown Toner will not degrade the quality of the microfilmed image. After brown toning, areas of redox blemishes may be clear or change to a more neutral color. Although the name "brown toner" suggests a browner image after toning, this is not true for microfilm. In fact, after brown toning, areas of density may appear blacker or more neutral in color. Brown toning does not affect the D-min or clear areas of the film when washed properly.

The first documented evidence of redox blemishing occurred in the early 1960s. One recommendation from the resulting investigation promoted the use of low concentrations of potassium iodide in the fixing bath (0.2 - 0.5 grams per liter)[3]. This has been shown to provide a good degree of protection against redox blemishes.IMAGELINK microfilm and IMAGELINK Archive Processor (*Prostar)* Fix solutions contain this stability-enhancing iodide. A second recommendation from this study was gold or selenium toning of the microfilm.

The Image Permanence Institute (IPI) at the Rochester Institute of Technology (RIT) in Rochester, New York extensively researched redox blemishes in microfilms[5]. IPI's research showed that selenium toning did not effectively stop the spread of redox IPI then looked at a polysulfide solution and IMAGELINK Brown Toner solution in place of selenium. IPI's testing showed both solutions stopped the migration of redox blemishes into the roll of microfilm. As a result of brown toning, toned microfilm has a higher resistance to the formation of redox blemishes. The combined use of brown toning and molecular sieves significantly enhances film longevity even under adverse conditions.

Based on the Kodak and IPI test results, Brown Toner has been shown to provide additional protection against environmental conditions that promote redox blemishes. The treatment is effective with freshly processed and existing microfilm collections.

IMAGELINK Brown Toner solution can be purchased from Eastman Park Micrographics:

EPM CAT No.	Packaging
140 0928	1 gallon container

Brown Toner is highly photoactive with microfilm chemicals. It is recommended that the handling of Brown Toner be done in a separate area from the handling of microfilm developer and fix.

Health and Safety

When a manufacturer has determined a product is or contains a hazardous chemical, they are required to provide a Material Safety Data Sheet (MSDS). EPM provides MSDSs with all photographic processing chemicals, even those that are not classified as hazardous chemicals. MSDSs are available by calling 1-866-934-4376, or on-line at www.epminc.com. You will need to supply EPM catalog numbers of the chemicals for which you need MSDSs. MSDSs, for the actual working solutions and caution labels for the processor tanks, are also available by calling the same number.

When working with photochemicals, it is recommended that MSDSs for all EPM products be obtained and consulted for information pertaining to potential hazards, safe handling guidelines, ventilation and personal protective equipment. While photo-chemical solutions and products may contain hazardous ingredients, if the information contained on the product label and within each MSDS is read, understood, and followed, normal use and handling of these products should not pose a health risk.

Post Processing Toning

Procedures

For Deep Tank Processors*

The deep tank processor is set to run at 90^{0}F. The transport speed is determined based on a recommended dwell time of 60 seconds in the brown toner solution. Depending on tank size, the transport speed varies between processors. Mix the IMAGELINK Brown Toner solution at a dilution of 1:100 (1 part brown toner solution to 100 parts water). Brown toning in deep tank processors can be performed either in-line (as part of the normal microfilm developing process) or off-line (use of a dedicated processor that brown tones microfilm after it has been processed in a separate processor). In an *Allen F-20* Processor for example, in-line brown toning can be accomplished by the following tank set-up:

Tank	Solution
1	Developer
2	Developer
3	Wash
4	Fix
5	Fix
6	Wash
7	Brown toner solution
8	Brown toner solution
9	Wash

Calculate the replenishment rate using the following table and formula:

Replenishment (mL/ft) by Film Width		
16 mm	35 mm	105 mm
0.60	1.20	3.60

Replenishment is equal to:
Processor Transport Speed x Table Value

Sample calculation for a deep tank processor:

Film Width:	16 mm
Table Value:	0.60 mL/ft
Transport Speed:	90 ft/min

Replenishment rate is equal to:
0.60 mL/ft x 90 ft/min = 54 mL/min.

Off-line brown toning in the *Allen F-20* Processor can be accomplished by filling any two consecutive tanks with IMAGELINK Brown Toner at the recommended dilution rate and at a temperature of 90^{0}F. A wash tank is required immediately after the second tank of brown toner. Set the transport speed to allow a 60-second dwell time in the brown toner solution and calculate the replenishment rate based on the formula described above.

** These are starting point recommendations. Final conditions will vary.*

For Table top Processors

Mix the brown toner solution at a dilution of 1:25 (1 part brown toner to 25 parts water). The temperature of the brown toner solution should be 100^0F. If the machine speed varies, adjust it to allow for a minimum of 33 seconds of dwell time in the brown toner solution.

As an example, the tank setup for a IMAGELINK A*rchival (Prostar*) Processor is the following:

Tank	Solution
1	Brown Toner
2	Brown Toner
3	Brown Toner
4	Brown Toner
5	Brown Toner
6	Wash

For this particular application, a constant machine speed of 10 feet/min yields a dwell time in the brown toner solution (all five tanks) of 33 seconds.

NOTE: These are starting point recommendations. Final conditions will vary.

Procedure to Ensure Post-Processing Brown Toning Efficiency

This procedure and specification are outlined in **ISO 18915, 2000-12-15,** Imaging Materials – Methods for the evaluation of the effectiveness of chemical conversion of the silver images against oxidation. The following procedure is used to verify that the brown toner solution has converted a sufficient amount of the developed silver-to-silver sulfide.

After the brown toner treatment has been completed, measure the Status A Blue density of the background density or any high-density area of an image on the microfilm and the density of a clear area (D Min) of the film. Subtract the density of the clear area from the density of the background area to obtain a delta density for the toned film.

Bleach portions of the microfilm containing the measured area with dichromate bleach (no dilution) for 30 seconds, rinse thoroughly and soak in sodium sulfite (100 g/L) solution or Clearing Bath solution for 30 seconds followed by a 1 minute water rinse and drying.

Re-measure the clear and high-density areas using a visual Status A Blue filter as described above and perform the same density subtraction. Divide the density difference after toning by the density difference before toning using the equation below.

$$\%\text{Retained density} = \frac{\text{Dmax} - \text{Dmin after Toning}}{\text{Dmax} - \text{Dmin before Toning}} \times 100$$

The retained density is an approximation of how much of the original silver image has been converted to silver sulfide. If the retained density is 65% or more, the image is considered stable. Density retention values less than 65% may still be stable based upon both the ISO standard and stability testing done at the Eastman Kodak Company.

NOTE: The method specifies the use of Status A Blue transmission density. The use of standard visual diffuse density will serve as a guideline but may yield slightly lower conversion ratios than Status A Blue measurements. Data generated in our laboratory indicates conversion measured using Status A Blue filtration is 50 to 100% higher than that using visual transmission density. As an example, when using visual diffuse transmission density a 1.0 background density image or higher, a conversion rate of 40% or more will actually be a conversion rate of 70% or more, thus meeting the ISO standard minimum of 65%.

Developer System Cleaner is available by ordering the following from Clayton (1-310 538 9530).

Part No.	Description	Quantity
99 0166	Developer Systems Cleaner	6 per case: in 64-oz bottles
99 0117		4 per case: in 1 gallon bottles

Conclusion

IMAGELINK Brown Toner, using the procedures described above, has been shown to meet the specifications for redox resistant film as described in ISO 18915, 2000-12-15[6]. All films toned at the EPM Quality Assurance Laboratory will be tested in accordance with these procedures. **ISO 18901:2002**[7], recognizes that microfilms given stabilizing treatments as described here are expected to achieve their full Life Expectancy (LE) of 500 years for polyester-based and 100 years for acetate-based films. If you have questions on brown toning, call your local EPM Representative or the EPM Quality Assurance Laboratory at 1-800-943-4561 or 800-352-8378

Sample Conversion Rate for Table top Processor

Dilution	Temperature	Dwell Time	Estimated % Conversion
1:25	100°F	33 sec.	82-91
1:50	100°F	33 sec.	76-87

Sample Conversion Rate for Deep tank Processor

Dilution	Temperature	Dwell Time	Estimated % Conversion
1:50	90°F	60 sec.	83-93
1:100	90°F	60 sec.	77-86

NOTE: Refer to the latest revision of each ANSI or ISO Standard specified.

References

1. ”Inspection of Processed Photographic Record Films for Aging Blemishes”, C.S. McCamy, *National Bureau of Standards Handbook 96*, January 24, 1964.
2. ”Microscopic Spots—A Progress Report,” D.G. Wiest and R.W. Henn*, National Micro-News*, 70, 249257, June 1964.
3. ”Microscopic Spots in Processed Microfilm—Their Nature and Prevention,” D.G. Wiest and R.W. Henn*, Photographic Science and Engineering*, 7 (5), 253-261 (1963) and “Micrographic Spots in Processed Microfilm: The Effect of Iodide,” R.W. Henn, D.G. Wiest, and B.D. Mack, *Photographic Science and Engineering*, 9 (3), 167-173 (1965).
4. ”The Effects and Prevention of the “Vinegar Syndrome””, A. Tulsi Ram, David F. Kopperl, Richard C. Sehlin, Stephanie Masaryk-Morris, James L. Vincent and Paige Miller, *Journal of Imaging Science and Technology*, Volume 38, Number 3, May/June 1994, Pp. 249-261.
5. ”Polysulfide Treatment for Microfilm”, James M. Reilly, D.W. Nishimura, K.M. Cuprika and P.Z. Adelstein*, Journal of Imaging Technology*, Volume 17, Number 3, June/July 1991, pp. 99-107.
6. **ISO 18915:2000** Imaging materials – “Methods for the Evaluation of the Effectiveness of Chemical Conversion of Silver Image Against Oxidation”. Available in English only.
7. **ISO 18901:2002** Imaging materials – “Processed Silver-Gelatin type Black-and-White Films – Specifications for Stability”. Available in English only.

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