PROTECTIVE OVERCOATING OF FILMS

This Report has been reviewed and
is approved.

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ABSTRACT

Kodak Film Type SO-212 was emulsion overcoated with gelatin and lacquer to evaluate the feasibility of application of the coatings, any image degradation, and the relative protection offered against abrasion. Evaluated were: Eastman motion picture film lacquer Type 485, water solutions of Eastman purified Calfskin gelatin, and experimental Eastman gelatin stripping film of 4 and 6μ.

All coatings can be applied with relative ease with the only limitation being that of equipment.

None of the coatings degrade the processed image.

All of the coatings provide protection to the emulsion.

These conclusions apply to any film which may be considered for overcoating.

SECTION I

INTRODUCTION

Task Order HT-49 was issued for the purpose of investigating the feasibility of applying protective coatings to film type SO-212. This film is quite sensitive to abrasion and pressure during handling, making it desirable to provide a means of protecting the emulsion after exposure.

Most silver halide photographic emulsions made today are routinely overcoated with gelatin. Certain spectroscopic emulsions of the Schumann type for far ultraviolet recording are the exceptions to this rule. Emulsions which are not overcoated exhibit severe pressure sensitivity and may show marks from being touched, from being folded or brushed along a hard object, and from pressure marks by being stacked too tightly or wound too tightly on a roll. These effects are accentuated as the ratio of gelatin to silver is decreased in the emulsion.

A "normal" emulsion would have a 1.5 to 2.5:1 weight ratio of gelatin to silver nitrate and a 1 to 3μ gelatin overcoat. Any additional compatible coating would protect an emulsion whether or not it has previously been overcoated. Any uncoated emulsion or any emulsion with a very low gelatin

ratio will be most sensitive to abrasion before processing. After processing the sensitivity to abrasion will decrease appreciably.

SECTION II

DESCRIPTION OF FILM

Kodak Spectrographic XUV, Type SO-202-1-1 on Estar thin base, wound emulsion out.

The film is 35mm, perforated, has a grey base and rem jet backing[1].

Microscopic examination of microtomed sections as illustrated in Figures 8-13 indicate the base is 75μ (3.0 mils), the emulsion about 7.5μ and the rem jet backing 2.1μ. Reportedly, the film has a very light overcoat. From an estimate based on swelling by water the overcoat is 2-3μ thick.

Sensitometric exposures were 1/5 sec. (I-B sensitometer with 3750Å filter). Processing of most strips was on the Hi-Speed color processor in D-19 (75°F and 6' 35" development) with manual rem jet removal by hose and sponge. The film has a good, clean minimum density and does not seem usually sensitive to handling marks, although special care was taken in handling. The H & D curve for a representative series of wedges is plotted in Figure 1. Resolution is of the order of 100 to 120 lines/mm as shown in Figure 3.

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[1]Bard, C. C. & Dunn, J. E., Journal SMPTE 80, 564 (1971).

Tracings on the Joyce-Loebl microdensitometer did not show the limit of resolution or granularity as adequately as photomicrographs and thus are not presented.

SECTION III

EXPERIMENTAL

A. Eastman Motion Picture Film Lacquer type 485.

This is the only film lacquer made by Eastman Kodak, and is readily available from Rochester. Usually, only motion picture release prints are lacquered since the hard lacquer surface will provide considerable protection to the abuse to which these prints are subjected.

Our coatings were made with 10μ doktor roller by placing the 35mm strips on a glass plate, pouring a small amount of lacquer at one end, and drawing the roller behind the liquid down the length of film. The solvent (flammable, somewhat toxic) evaporates quickly and the coating is hard in a fraction of a minute.

All lacquer coatings were applied to processed strips since the material acts as a water barrier, as shown in the series Figures 12 and 13. Kodak does not specify percentage of solids but a 10μ solution coating which produces an estimated 1μ dry coat would be 10% solids. Removal of 90% volatile, toxic, flammable organic solvent should be considered for any installation of this equipment.

The attractive features of this coating are that it is

fast and simple. It is simple in that the low viscosity of the lacquer solution allows it to smooth itself out as a liquid film and is usually applied with a wick or pad. This is an extremely crude method of coating application, and the fact that it works attests to the utter simplicity of this operation.

Figures 3 and 7 may be compared to indicate any microscopic changes in the image due to lacquer coating. A weighted stylus test for hardness will be done by Kodak and reported later. Rereading sensitometric strips indicated deviations between +.05 and -.04 density units with the largest changes in the high density region. The variation was random, not systematic, indicating coating quality was probably at fault.

B. Experimental Gelatin Stripping Film.

Eastman Kodak provided several samples of experimental stripping film (P-789-145-1 and -2, dated 1/20/70.) It consists of a 70mm wide acetate support film onto which a layer of unhardened gelatin has been coated. The material should be stored and used at less than 50% humidity (68°F) to prevent delamination.

In use, a strip of SO-212 film was taped to a glass plate and a chilled solution of 1:1 methanol : water was poured at

one end. The stripping film was placed over this and rolled down the length of SO-212 with the wetting solution preceeding the contact.

This operation was performed both before and after processing with essentially identical results. The sensitometric results of coating prior to processing are given in Figure 1.

The problems associated with differential adhesion make it a very touchy operation. When it works it is an elegant and simple operation. When it does not work it is worse than having no coating at all. Temperature and humidity of all materials and equipment must be closely maintained, as must the manufacture and storage of the stripping film itself. The major problem is keeping the adhesion to the substrate higher than the adhesion to the support during the stripping operation. If this balance should be lost, delamination, air bubbles, and a wrinkled or folded coating will result. The only way to correct this situation is to have means available to remove all of the overcoat.

If the stripping film is applied after processing it must be hardened. This can be accomplished by running the material through a hardening bath in regular processing machinery. If the sprocket holes are to be used in the coated film, the stripping layer must go between them and this requirement

would be an added difficulty in machine design.

Stripping film is not a commercial product and no commercial application has been found in any available information.

Figures 3 and 6 may be compared to indicate any microscopic changes in the image due to coating with stripping film. A weighted stylus test for hardness will be done by Kodak and reported later. Reading the sensitometric strip after coating indicated slightly lower densities across the wedge and ranging from -.01 density units at the low exposure end to -0.10 at the high density end. Part of this is due to the thick coating acting as a lens.

C. Gelatin Solutions

Inert photographic gelatin is readily available from a number of sources around the world. Other additives normally used in overcoat formulations are presently in use in the laboratory.

Preparation of the solution involves soaking the gelatin in water and then heating with vigorous agitation to 110-140°F until a homogeneous solution is achieved. This solution may then be cooled to coating temperature, about 95°F, and any additives are put in. Only a wetting agent was added as hardening was done in a subsequent operation. Percent solids is dependent on the type of equipment in use and 7% was found to be a convenient value.

The coating may be done either before or after processing. H & D curves from pre- and postprocessing overcoats are illustrated in Figure 1. The reason for the separation of the two curves is not known but may be due to the fact that the coating was quite thick or the coating was made at the wrong pH.

Coating procedure was similar to the lacquer operation.

Preparation of the gelatin solution for production would require a mixing area and several hours of time. Before being fed to the coating stage, the solution would normally be tested for viscosity and pH, be filtered and deaerated (an ultrasonic cleaner would remove bubbles). Coating could be by a dip or skim process, gravure or extrusion. Immediately after coating the film should be chilled to about 50-60°F to set the gelatin. Drying must be controlled and involves placing the film on a flat bed or festooned in a long or high drying tunnel. Obviously, this sounds like a lengthy, complicated process requiring a lot of specialized equipment and a lot of space. It is and it does. It is also a well proven system and extremely versatile -- certainly more versatile than present requirements indicate.

Figures 2 through 5 show the relationship between no overcoat and an emulsion overcoat from a gelatin solution. A weighted stylus test for hardness will be done by Kodak and

reported later. After coating, several strips were again read on the densitometer. Slightly lower optical densities were found corresponding to the observations with the stripping film overcoat. Since both coatings were near the same thickness and of the same material the same reason for the change would apply.

SECTION IV

SUMMARY

The following considerations are applicable to any type of film being considered for overcoating.

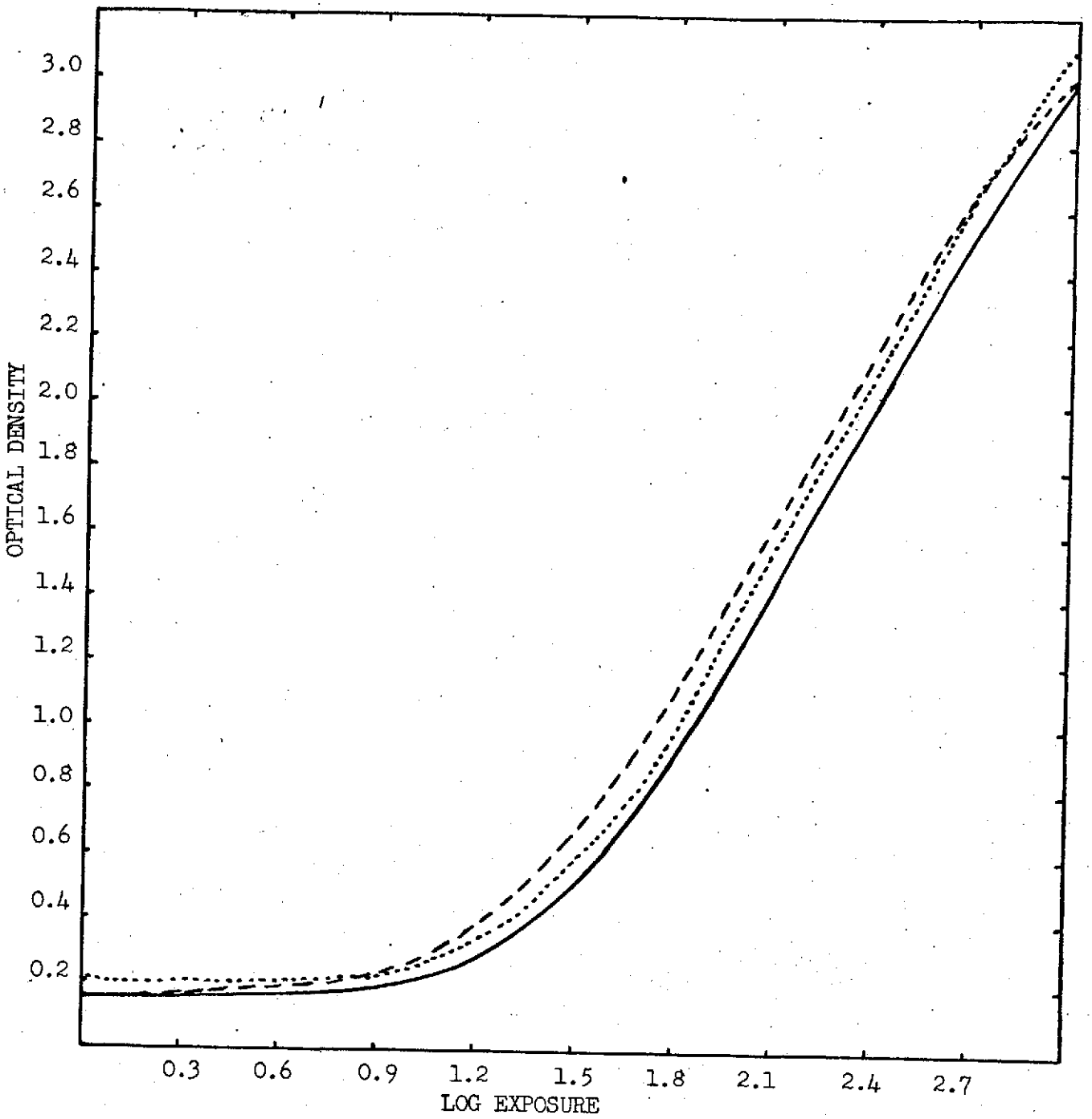
	Lacquer	Stripping Film	Gel Solution
Equipment			
plus factors	simple equipment high speed, (may be done by Technicolor, Hollywood)	simple equipment	highly versatile
negative factors	solvent removal	an operation of this type has no commercial counterpart. Material is experimental.	equipment cost, equipment room, (drying space esp.) Lengthy sequence of operations
Operator	average skill	average skill	highly skilled (several technicians may be required)

SECTION V

RECOMMENDATION

The thin overcoat put on this film during manufacture provides sufficient protection for careful application of sensitometry, rewind, and process with a clean D-min and no apparent image damage. Unless it is intended that the original will be shown on demand in a home filmstrip projector, quality copies can be produced with no further film treatment.

Figure 1
SENSITOMETRIC CURVE FOR EASTMAN TYPE SO-212 FILM
Developed in D-19 at 75°F.



——— Uncoated Film Processed on Hi-Speed Processor (Average of 19 Strips)

– – – – Film Coated with 5% Gelatin Solution Before Processing on Hi-Speed (Average of 5 Strips)

····· Film Coated with 4μ Stripping Film Before Processing on Malt Mixer (Single Strip)

Resolution Friskets on Sensitometric Strips Magnified 58X
From Eastman Film Type SO-212

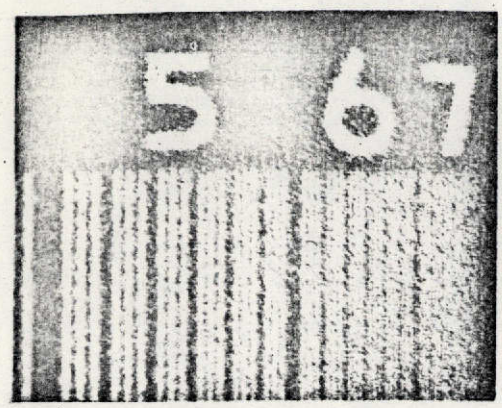


Figure 2
From Wedge Step #11, Normal Film.

Figure 3
From Wedge Step #17, Normal Film.

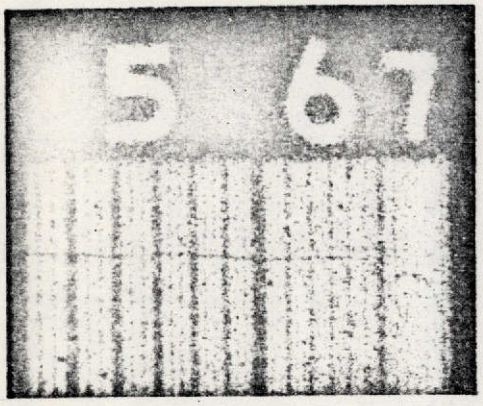


Figure 4
Same Frisket as Figure 2. Overcoated with 7% Gelatin solution after processing.

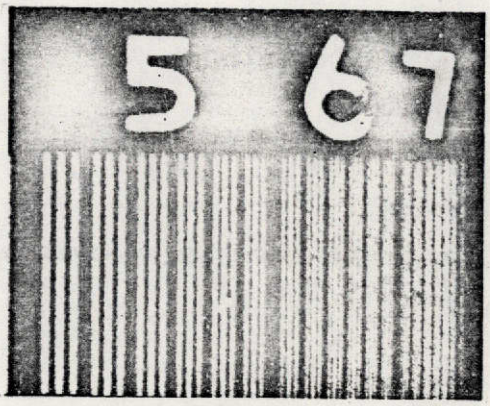


Figure 5
Same frisket as Figure 3. Overcoated with 7% Gelatin solution.

Figure 6
From wedge step #17 after overcoating with 6μ stripping film.

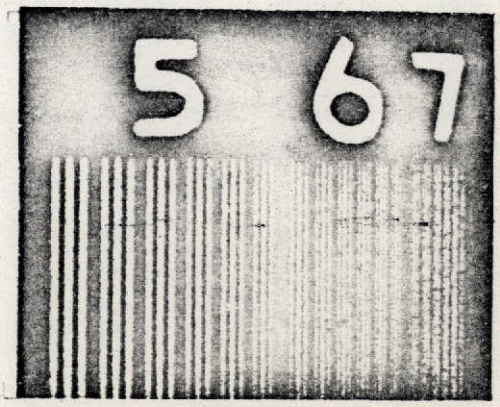


Figure 7
From wedge step #17 after coating with lacquer.

Microtomed Slices (10μ) of Processed Eastman Film Type SO-212

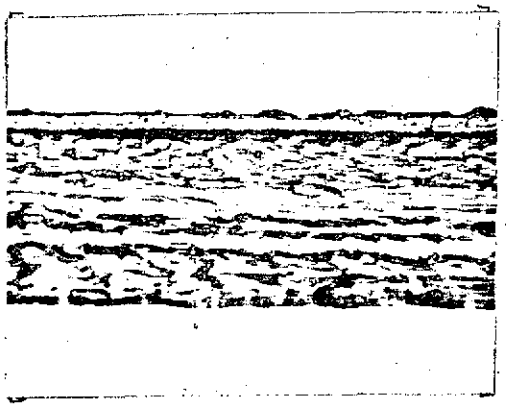


Figure 8
Coated with 6μ Stripping Film.
Overcoat measures 8.6μ.

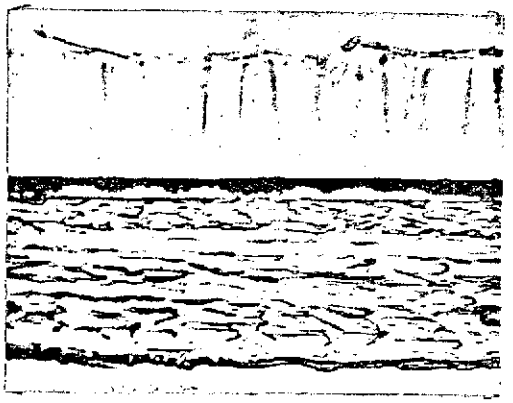


Figure 9
Same as Figure 8 after wetting.
Overcoat is 60 - 65μ.

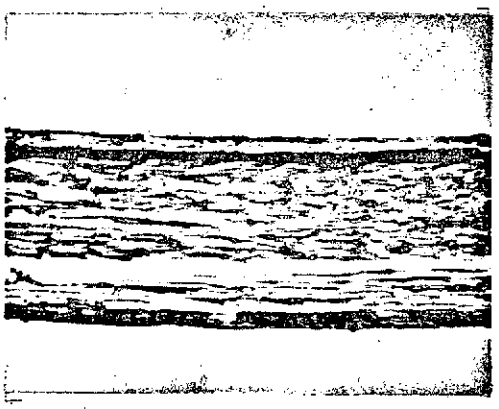


Figure 10
Coated with gelatin solution.
Overcoat measures about 7μ.

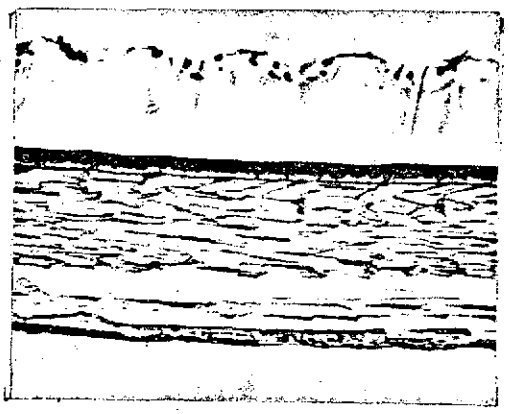


Figure 11
Same as Figure 10 after wetting.
Overcoat is about 50μ.

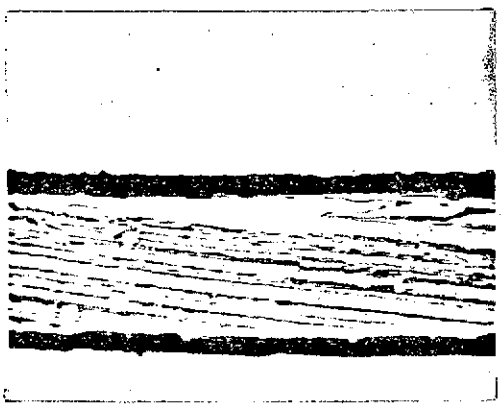


Figure 12
Overcoated with lacquer.
Coating is less than 1μ thick.

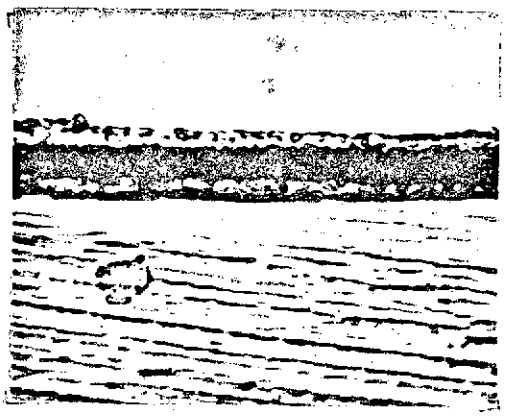


Figure 13
Same as Figure 12 after wetting.
Swollen lacquer is 3 - 5μ.