THE USE AND IDENTIFICATION OF PLASTIC PACKAGING FILMS FOR CONSERVATION

by Thomas O. Taylor

The use of the "right" plastic film in conservation work is a great deal like wearing seat belts. It is possible that the packaged item may never be effected by a questionable film. Storage conditions could be perfect. But, like the good seat belt, if conditions and situations change, you, or someone, will wish you had the "right" film.

Most items requiring preservation need protection from dirt, light, atmosphere and handling. An inert, stable, packaging material that allows visibility of the contents, without removal of the item, is preferred. A transparent wrap is best -- something that was not available to conservators until this century.

A History of Plastic Films

Plastics got their start with celluloid and the development of a replacement for ivory in billiard balls. In 1868 John Hyatt mixed collodin with camphor and alcohol to win a $10,000 prize for finding the billiard ball substitute. Then came celluloid collars, cuffs, etc. After the turn of the century, Jacques Brandenburger, seeking a way to keep wine stains off French tablecloths, invented cellophane. Cellophane is basically a refined paper (made from wood pulp) and coated in most cases to give barrier and heat seal properties. In 1923 when Du Pont de Nemours & Company began to produce cellophane in this country, it was an attractive, expensive film used to package perfumes and other products. By 1927, Du Pont had developed nitrocellulose coatings for barriers and heat seals. After World War II, polymer coatings were added and since the 1960s most cellophane has been coated with PVDC ("Saran").

The major growth for cellophane, and all plastic films, started during the late 1930s and after World War II when self-service shopping came into vogue. Instead of a clerk measuring out a purchase, shoppers helped themselves to pre-weighed and priced units. Many packages required transparency because people wanted to see what they were buying. During World War II there were three transparent packaging films in general use in war work: cellophane, acetate, and rubber hydrochloride. Since that war, there have been many, many films added to the list available for packaging. Polyethylene resin was produced first by ICI Limited, a British manufacturer, in 1933. Du Pont introduced it to this country in 1950. Another film (again developed by ICI and brought to the U.S. in the early 1950s by Du Pont) was polyethylene terepthalate (or polyester, or "Mylar" as Du Pont called it). This film is a result of adding glycol to terepthalic acid. The result is an inert, dimensionally stable, strong film that can be made very clear in a number of thicknesses (or gauges). It is cast as a flat film from a horizontal extruder on to a casting roll and then stretched in both directions to orient the molecules and "set" the film permanently. There are many forms of "Mylar": unpolished industrial grades, heat-shrinkable, metallized, coated with

PVDC, ovenable, embossed, etc. The accepted one for conservation is Du Pont's "Mylar Type D."

Blown film (most polyethylene and many others) is extruded vertically in tubular form from a circular die. It is then air blown to the desired thickness while chilling. It can then be slit and wound up on a roll.

Selecting Films for Conservation Today

Today there are many forms of transparent film available for packaging made by a large number of firms (there are at least 200 polyethylene film producers in the U.S. alone). For the conservator, film selection is important. You need the right "seat belt."

1. Some films have basic ingredients or residual chemicals that are questionable. PVC has hydrochloric acid in its decomposition products, and under unfavorable conditions (heat, pressure, and moisture) can revert to an acidic "glop." Cellophane is made with carbon disulphide and H_2SO_4 is also used in the process. Like paper, the acid content remains in the film to some extent.

2. Other film ingredients could present problems for a conservator. Plasticizers used in making many films can migrate and react with paper, inks, print emulsions, etc. Coatings (nitrocellulose PVDC, and acrylic) should be generally avoided. An old advertisement by 3M (Minnesota Mining & Manufacturing Company) points up the problem. The ad promotes a PVDC coated polyester but admits that "We ship millions of pounds of this stuff every year -- but we don't know where it all goes." Usually a large manufacturer would caution a

conservator against using a PVDC-coated polyester but the manufacturer may not know of your use and the distributor or converter may not know if a PVDC coating is to be avoided in conservation.

3. There are some solvents used in the manufacture of polyethylene resin to introduce other ingredients into the final product. Solvents are also used to apply coatings to other films. It is very difficult to remove all solvents from film and the residual amount can cause trouble.

4. There are additives like slip agents (talc, clay, or silica are applied to films after they are made to act like tiny ball bearings on the film surface) which can cut an emulsion. One anti-oxident (butylated hydroxy toluene added to polyethylene resin to make the film produced from the resin less prone to "gels" or "fisheyes") evidently causes textiles to turn yellow. It is not known how the anti-oxident affects paper. Additives should be avoided.

5. "Dimstab" is an industry word used to describe the dimensional stability of a film. Cellophane, for instance, has poor dimstab because it is about 6.5% water and 17% softeners that migrate with time and temperature fluctuations. The result is that cellophane can shrink greatly (and get brittle) over time. But dimstab has to be considered with regard to heat also. Some tests were run in spring 1985 on five films available for conservation work. Albumen print samples (1 1/2" square) were sandwiched between two sheets each of triacetate, polystyrene, polypropylene, polyvinylchloride, and polyester. Stacks of samples were then exposed to three different temperatures (while under a pressure of 1.5 lbs. per square inch) for a period of twenty-five days. In addition, the same grouping

was subjected to tropical conditions. The first group was exposed to temperatures of 130°F, 195°F and 248°F. The tropical group was exposed to 100°F at 95% RH.

The results dramatically showed that only the polyester ("Mylar Type D") did not indicate film distortion under any of the conditions employed. And there was no sticking of the film to the photographic print surface with polyester. See Tables 1 and 2.

TABLE 1

Film distortion: twenty-five day test duration

Film type	130°F	195°F	248°F
OPS (polystyrene)	No	Yes	Melt
TRIA (triacetate)	No	No	Yes
PP (polypropylene)	No	Slight	Yes
PVC (polyvinylchloride)	No	Yes	Melt
PET (polyester)	No	No	No

TABLE 2

Tackiness of films to photographic print: forty day test, 100°F 90% RH

Film Type	Tackiness
OPS	None
TRIA	None
PP	Slight Tackiness
PVC	Sticking
PET	None

Is it practical to consider heat exposure of 248°F for material requiring conservation protection? Beyond the hazards of fire in a storage area, there is the danger of exposure to natural weather conditions. The author knows, firsthand, of an incident involving the shipment of cellophane bags to Florida one summer. All the bags in the top layer of cartons in the trailer were completely sealed together when the truck was parked in a terminal lot over the weekend. Cellophane bag coatings begin to fuse at about 220°F.

6. Films should not change color over periods of time. Cellophane and some of the plastic films will turn yellowish with age or chemical change.

7. Film strength is important. If films crack or break with age or repeated flexing, they will have to be replaced.

8. Films should be as resistant as possible to reactions with outside conditions. Some films absorb solvents readily. They can blot up the solvents in the atmosphere or any adjacent item that has solvents to spare. And almost all plastic films show high static content which will attract dust and grit. Even polyester has its problems in this regard. Cellophane is the most static-free of all films but should not be used for other reasons.

From a barrier property standpoint, uncoated films perform differently. Uncoated cellophane and acetate are not barriers to moisture or gas. Polyethylene (low density variety) is a good moisture barrier but has a high gas transmission rate. Polypropylene and polyester are relatively good barriers for moisture and gas -- and the thicker the film, the better the barrier.

9. Mechanical film properties (roughness, sharpness, clarity, and "cling") are factors in choosing a film for conservation work. A sharp edge or point on a polyester pouch could damage a print when the item is being inserted, but the film's smooth surface and clarity offset this negative factor. Most plastic films have a "cling"

problem due to static. Sliding a print or document into a tight fitting three seal pouch can be an adventure.

Identifying Films

The following charts give a basic "desk top" system for determining the identity or family of a number of transparent plastic films. The first chart (Table 3) covers simple stretching and tearing while the second (Table 4) concerns heating and burning tests.

A method to reveal the presence of PVC, PVDC, or rubber hydrochloride requires the use of a piece of no. 8 or no. 10 guage copper wire and a propane torch. Strip the vinyl cover off one half of a two foot length of wire, and burn off the residual wire cover vinyl from the exposed copper. It will burn with a green flame. When the flame turns orange, touch the red-hot copper tip to the unidentified film sample and then place it back in the flame. If it burns green, vinyl chloride is present and the film should not be used.

Conclusion

Based upon all the preceding factors and considerations, the author's choice for the best conservation packaging film is polyester in an uncoated, biaxially oriented, polished form. In a second choice grouping would come triactate, archival polypropylene, archival polystyrene, and polyethylene without additives. The last two may not be available for purchase. Finally, cellophane, polyvinylchloride, polyvinylidene chloride ("Saran"), and rubber hydrochloride should not be used.

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TABLE 3

Film Identification: Heat and Burn Test Chart

Material	Heat Test	Burn Test: Odor	Burn Test: Rate
Cellophane: Uncoated N/C Coated PVDC Coated	Does not deorient due to heat normalization, will become brittle and shrink slightly due to moisture loss	Burnt newsprint (like paper)	Does not melt, drip, or form beads; burns same as paper; continues to burn when withdrawn from flame
Oriented Polyester: Uncoated Coated	Deorientation and severe shrinkage takes place past heat set point (approx. 300-350°F)		Melts, burns slowly, beading back without dripping, leaves an ash residue
Oriented Polypropylene: Uncoated Coated	Deorientation and severe shrinkage takes place past heat set point (approx. 280-300°F)		Melts, burns slowly, beading back without dripping
Polyethylene	10% approximate shrinkage	Like burning candle wax	Fairly rapid; melts and drips like wax
Polystyrene		Like marigolds	Melts into clear liquid
Oriented Polyvinylidene Chloride (Saran)	Deorientation and severe shrinkage takes place past heat set point	Pungent, resin mixture	Extinguishes itself when removed from flame
Cellulose Acetate		Mixture of Acetic and burning paper	Burns slowly when removed from flame; beads at burnt edge

TABLE 4

Film Identification: Stretch and Tear Test Chart

Material	Stretch Test	Tear Test
Cellophane	Hard to stretch	Easy to tear
Cellulose triactate	Easier than polyester to stretch	Fairly easy to tear, "smokey" edge to tear
Polyester (oriented)	Hard to stretch	Hardest to initiate tear, easy to propagate a tear, tears with rough edge
Polypropylene (oriented, balanced biaxally)	Easier than polyester and balanced elongation	Hard to initiate tear, easy to propagate tear, tears with clean edge like cellophane
Polyethylene	Easier to stretch	Hard to tear, tears in most directions almost always
Polyvinylchloride	Easier than polyester	Moderately easy to tear (both initiate and propagate); ragged tear
Polystyrene	Hard to stretch	Easy to tear (both initiate and propagate); clean tear but not straight