For the

Coatings Market

EASTMAN Cellulose Acetate for Coatings

EASTMAN

Contents

Cellulose Acetate for Coatings

Introduction

Eastman cellulose acetate has a long history of use in coatings applications requiring its special characteristics of high melting point, toughness, clarity, and good resistance to ultraviolet light, chemicals, oils, and greases.

Cellulose acetate is produced by controlled esterification of purified raw cellulose with acetic acid and acetic anhydride. In this process, acetyl groups are substituted for all or a portion of the hydroxyl units on the cellulose chain. In order to obtain soluble cellulose acetate esters, the acetylation is carried to completion to form cellulose triacetate, followed by hydrolysis, which lowers the acetyl content to the desired level. The presence of both acetyl groups and relatively smaller hydroxyl groups on the cellulose chain reduces the regularity of chain structure.

Cellulose acetate esters of particular interest to lacquer manufacturers fall within a range of 38% to 40% acetyl content, between cellulose triacetate and cellulose diacetate. These esters are designated as lacquer-type cellulose acetate. Reducing the number of acetyl groups on the cellulose triacetate molecule to an acetyl content of 38% to 40% changes the solubility characteristics in a favorable direction. Several solvents of medium polarity will dissolve the resulting material, in contrast to the limited number of useful solvents found for triacetate.

Types and Typical Properties

Figure 1 shows the chemical composition of *Eastman* cellulose acetate. The degree of substitution of a cellulose acetate may be expressed as any of the three interrelated values—acetyl content, combined acetic acid content, or hydroxyl content. As the hydroxyl content increases, the acetyl or combined acetic acid content decreases.

Acetyl and hydroxyl contents vary only slightly within the group of lacquer-type cellulose acetate esters (shaded portion of Figure 1). These materials are consequently similar in solubility and melting range, and they differ only slightly in moisture absorption, which decreases with an increase in acetyl content (Figure 2).

Figure 1
Approximate Composition of Lacquer-Type *Eastman* Cellulose Acetate

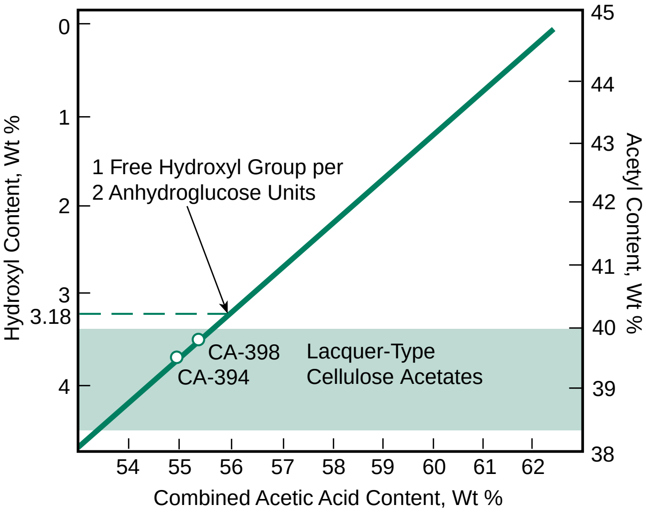
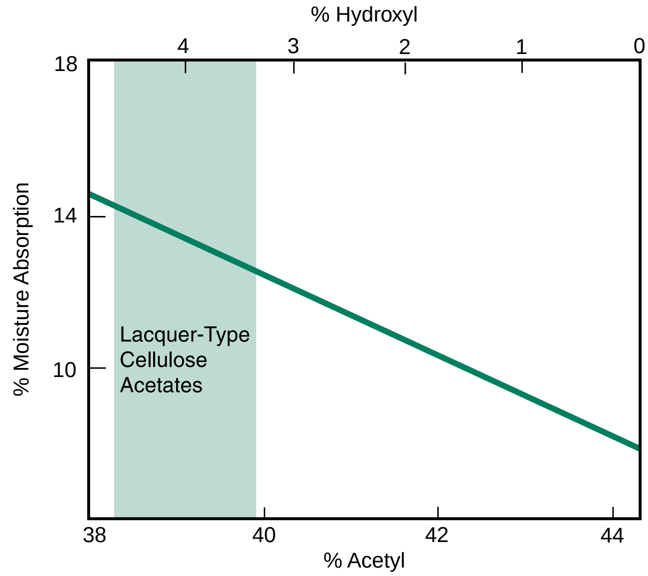
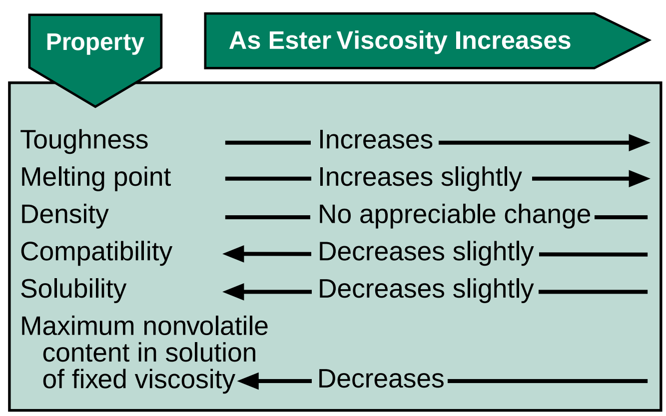


Figure 2
Moisture Absorption of Cellulose Acetate @ 95% RH, 25°C (77°F)



Lacquer-type cellulose acetate esters are available in a wide range of viscosities, the ester viscosity being directly related to the average molecular weight and chain length of the ester. Figure 3 illustrates how viscosity influences the physical properties of the esters and the films produced from them.

Figure 3
Effect of Viscosity on Cellulose Acetate Properties



Selection

Table 1 lists typical properties of lacquer-type *Eastman* cellulose acetate esters. Film and lacquer properties needed for a particular application may be adjusted by changing the ester type or viscosity.

Lacquer-type esters are soluble in several organic solvents suitable for use in industrial coatings. Changes in solution viscosities to meet the requirements of specific methods of application may be accomplished by using an ester of higher or lower viscosity, thereby effecting a corresponding increase or decrease in the formulation viscosity.

A slight improvement in compatibility with plasticizers or resins may be obtained by using lower-viscosity esters, but changes in the solvent system or other modifying ingredients usually have a greater effect.

In general, higher-viscosity esters provide increased film toughness properties and a slight increase in melting point.

To aid the coatings formulator in preparing and evaluating cellulose acetate formulations, the following sections discuss solubility, resin and plasticizer compatibility, and performance of lacquer-type esters.

Table 1
Typical Properties of *Eastman* Cellulose Acetate[a]
(Lacquer Types)

	Filtered Powder				
Property	**CA-394-60S**	**CA-398-3**	**CA-398-6**	**CA-398-10**	**CA-398-30**
Acetyl content, wt % (avg)	39.5	39.8	39.8	39.8	39.7
Combined acetic acid content, wt % (avg)	55.0	55.5	55.5	55.5	55.5
Hydroxyl content, wt % (avg)	4.0	3.5	3.5	3.5	3.5
Viscosity, sec[b] (avg)	60.0	3.0	6.0	10.0	30.0
Viscosity, P[b] (avg)	228.0	11.4	22.8	38.0	114.0
Color, ppm[c] (avg)	635	80	80	80	290
Haze, ppm[c] (avg)	40	25	25	25	40
Ash, % (max.)	0.05	0.05	0.05	0.05	0.05
Free acidity, as acetic acid, wt % (max.)	0.1	0.1	0.1	0.1	0.2
Refractive index	1.475	1.475	1.475	1.475	1.475
Melting point range, °C	240–260	230–250	230–250	230–250	230–250
Specific gravity	1.32	1.31	1.31	1.31	1.31
Wt/vol					
kg/L	1.32	1.31	1.31	1.31	1.31
lb/gal	11.10	10.90	10.90	10.90	10.90
Bulk density, tapped (avg)					
kg/m^3	400	400	400	400	432
lb/ft^3	25	25	25	25	27
Bulk density, as poured (avg)					
kg/m^3	320	320	320	320	320
lb/ft^3	20	20	20	20	20
Dielectric strength [10-mil (250-micron) film]					
kv/cm	669	669	669	669	669
kv/mil	1.7	1.7	1.7	1.7	1.7

[a]*Properties reported here are typical of average lots. Eastman makes no representation that the material in any particular shipment will conform to the listed properties.*

[b]*Viscosity determined by ASTM Method D 1343 in the solution described as Formula A, ASTM Method D 817.*

[c]*Determination of color and haze made on CAB solution using Pt-Co standard (color) and a monodisperse latex suspension (haze). Analysis is performed with a* Gardner *Model XL-835 Colorimeter.*

Solubility

Success of the application and quality of a protective coating depend to a great extent on the solvent system. Each component of a solvent system is selected to fulfill a definite function—active solvents for their solvency power, diluents for their economic advantage, cosolvents for their reduction of solution viscosity and, in many applications, retarder solvents for their slow evaporation rates.

Solution Viscosity in Various Lacquer Solvents

Lacquer-type *Eastman* cellulose acetate esters form good solutions in several solvents. These solvents are characterized by a range of boiling points or evaporation rates, enabling the formulation of useful compositions.

Table 2 shows the solubility of CA-398-3 in a series of commercial lacquer solvents and various mixtures of these solvents. While results listed for CA-398-3 serve as a general indication of the solubility of lacquer-type cellulose acetate esters, actual solution viscosity values will vary for other ester types according to composition and viscosity.

Among fast-evaporating solvents, acetone is one of the most important and widely used for cellulose acetate because it produces solutions of considerably lower viscosity at a given solids content.

Lacquer-type cellulose acetate esters are insoluble in nonpolar solvents such as toluene and solvent naphtha. However, these materials are useful as diluents in mixtures with active solvents.

Table 2
Solubility of CA-398-3[a]

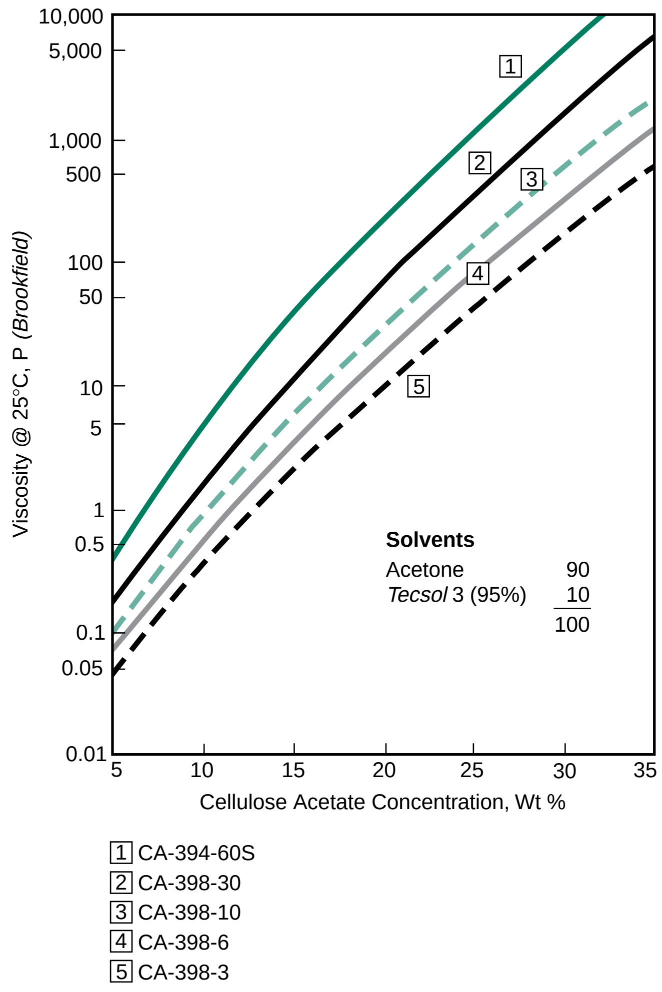
	Solvent	Solution Viscosity (15% concn), 25°C, cP (mPa·s)
80:20	Acetone[b]:methyl alcohol	175
	Acetone	190
90:10	Acetone:*Tecsol* 3 (95%) ethyl alcohol[b]	270
	Methyl acetate	335
80:20	Methylene chloride:methyl alcohol	450
50:50	Nitroethane:*Tecsol* 3 (95%) ethyl alcohol	555
80:20	Nitroethane:*Tecsol* 3 (95%) ethyl alcohol	650
	Methyl ethyl ketone (MEK)	750
80:20	Ethyl acetate[b]:*Tecsol* 3 (95%) ethyl alcohol	845
80:20	Ethylene dichloride:methyl alcohol	865
	Nitromethane	1,530
	1,4-Dioxane	2,480
	Isophorone	4,880
	Cyclohexanone	6,620
	Ethyl lactate	6,740
	Diacetone alcohol	9,650
	Methylene chloride	16,800
	Eastman PM acetate (propylene glycol monomethyl ether acetate)	Borderline solubility
	Ethylene glycol monoethyl ether acetate	Borderline solubility
	Nitroethane	Borderline solubility
	Ethylene dichloride	Borderline solubility
	Tetrachloroethane	Borderline solubility
50:50	Ethylene dichloride:methyl alcohol	Borderline solubility
	Methyl n-propyl ketone (MPK)[b]	Insoluble
	Methyl isobutyl ketone (MIBK)[b]	Insoluble
	Methyl n-amyl ketone (MAK)[b]	Insoluble
	Methyl alcohol	Insoluble
	Tecsol 3 (95%) ethyl alcohol[b]	Insoluble
	Eastman EB (ethylene glycol monobutyl ether)	Insoluble
	Isopropyl acetate	Insoluble
	Ethyl ether	Insoluble
	Nitropropane	Insoluble
	Toluene	Insoluble
	VM&P naphtha	Insoluble
	Eastman EP solvent (ethylene glycol monopropyl ether)	Insoluble
	Eastman EEP solvent (ethyl 3-ethoxypropionate)	Insoluble
	Eastman PM solvent (propylene glycol monomethyl ether)	Insoluble

[a]*As measured with a* Brookfield *viscometer*
[b]*Eastman*

Solution Viscosity as Influenced by Ester Concentration

Figure 4 shows the effect of ester concentration on solution viscosity of lacquer-type cellulose acetate esters. A solvent system composed of *Tecsol* 3 (95%) ethyl alcohol and acetone was used. While viscosity values will differ in other solvent combinations, the same general relationship between the curves will remain. Within this group of cellulose acetate esters, variation in acetyl content between the esters is relatively small; thus, ester viscosity has the major effect on solution viscosity.

Figure 4
Effect of Ester Concentration on Solution Viscosity of Lacquer-Type *Eastman* Cellulose Acetate

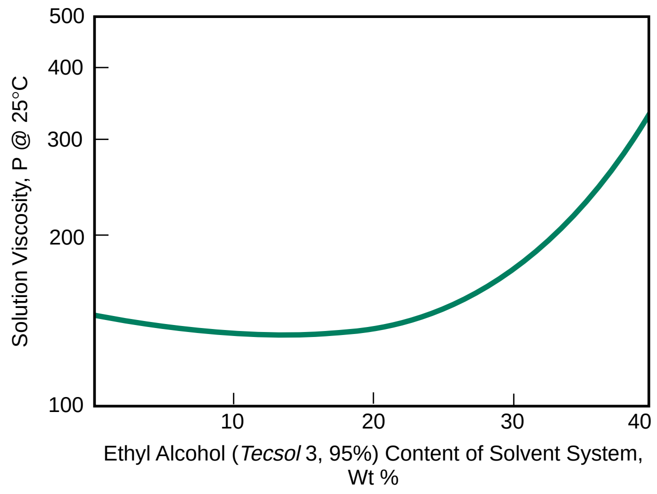


Solution Viscosity as Influenced by Alcohol Content

Although alcohols alone are not solvents for lacquer-type cellulose acetate esters, adding one of the lower alcohols to a cellulose acetate solution often lowers the viscosity slightly. Figure 5 shows an example of this effect. A 30% solution of CA-398-3 in acetone and *Tecsol* 3 (95%) ethyl alcohol is used in the test. The graph shows that up to 30% alcohol content may be used in a lacquer before the effect on solution viscosity becomes impractical.

The amount of alcohol that may be used in a cellulose acetate lacquer is dependent on the concentration of cellulose ester used. At a low ester concentration of 5%–15%, clear films are only obtained with acetone and up to 90:10 acetone: alcohol mixtures; at 30% concentration, clear films can be obtained from acetone:alcohol mixtures containing up to 35% alcohol. As previously noted in Table 2, several solvents that are not active solvents for cellulose acetate by themselves become active with the addition of alcohol. These include ethyl acetate, ethylene dichloride, and nitroethane.

Figure 5
Effect of Alcohol on Solution Viscosity of CA-398-3 (30% ester concentration in blend of acetone and *Tecsol* 3, 95%, ethyl alcohol)



Influence of Diluents on Lacquer and Film Properties

The addition of diluents to CA-398-3 solutions at concentrations of 5%, 15%, and 30% solids in acetone and in acetone:*Tecsol* 3 (95%) ethyl alcohol mixtures was studied. The concentration of cellulose acetate had a definite effect on the amount and type of diluent that the system could tolerate. From the standpoint of solution and film appearance, toluene can be used to advantage at high ester concentration but gives hazy solutions and films when used in systems containing a low cellulose ester concentration. Incorporating xylene in cellulose acetate systems gives clear films only when the cellulose ester content is high.

Cellulose acetate of 38%–40% acetyl content is quite hydrophilic compared with triacetate and mixed esters such as cellulose acetate butyrate. Thus, the amount of water tolerated in a solution of cellulose acetate is of interest. Studies of acetone:*Tecsol* 3 (95%) ethyl alcohol:water solutions of CA-398-3 indicated that only 2%–5% water can be tolerated. The small amount of water that can be tolerated has no positive effects, as there are no improvements in the properties of films coated from this system, nor is the viscosity of the lacquer reduced.

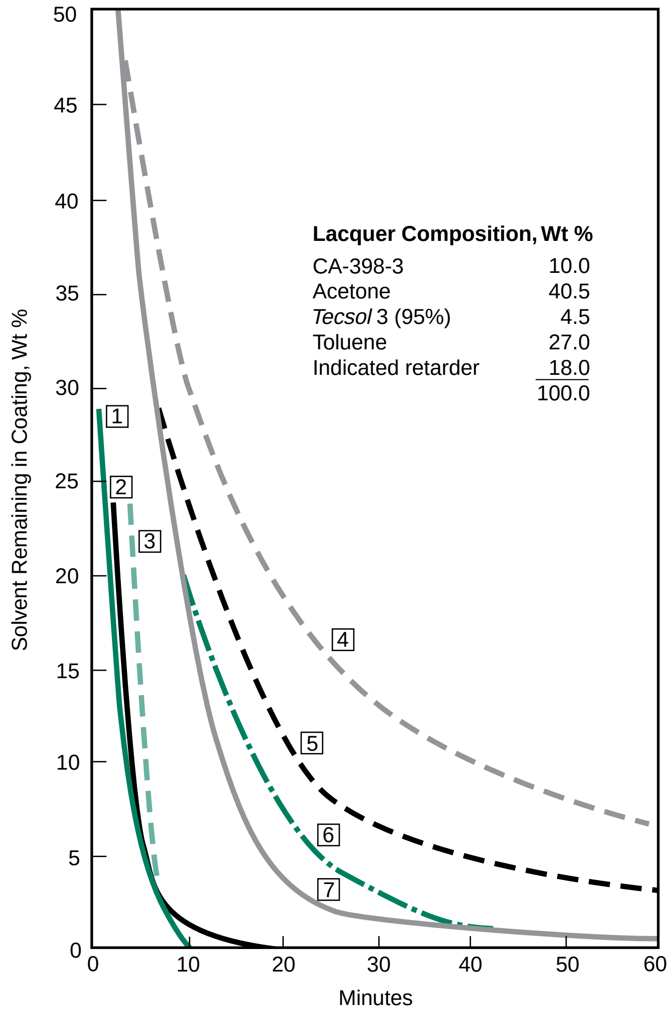
Retarder Solvents for Cellulose Acetate Lacquers

For some applications in which rapid drying and low penetration of the coating are desired, a single low-boiling solvent such as acetone or a binary mixture such as 90:10 acetone:*Tecsol* 3 (95%) ethyl alcohol proves satisfactory. However, for applications in which it is desirable to retard the evaporation rate to increase flowout and penetration of the coating, it is necessary to incorporate a slower-evaporating solvent.

The data in Table 3 and Figure 6 indicate the suitability of several typical retarder solvents for use with cellulose acetate. Table 3 shows the effect of the retarder solvent on the solubility of cellulose acetate as denoted by solution viscosity. Incorporating retarder solvents significantly reduced the evaporation rate of the solvent system and in some cases permitted incorporation of 10–30 wt % toluene in the solvent system. Films prepared from these solutions were clear except when noted otherwise.

Figure 6 illustrates the effect of retarder solvents on the evaporation rate of a typical lacquer solvent system.

Figure 6
Effect of Various Retarder Solutions on Evaporation Rate of Solvents From CA-398-3 Lacquer Coatings



Controls
1. Acetone, no retarder
2. 90:10 acetone:*Tecsol* 3 (95%), no retarder
3. 62% acetone:*Tecsol* 3, 95% (90:10) 38% toluene, no retarder

Retarder
4. Diacetone alcohol
5. Cyclohexanone
6. *Eastman* PM solvent
7. *Eastman* PM acetate

Quintel EV-1 Processor-Based Evaporometer, 23°C, 35 SCFH Bottled N_2. EV-1 Standardization: The N_2 flow rate for the upper cavity was adjusted to provide an evaporation time of 470 ±10 seconds for n-butyl acetate per ASTM D 3539-76 Method B, 23°C.

When retarder solvents were incorporated as 10% of the solvent system in the absence of toluene, all those evaluated showed promise for cellulose acetate lacquers. Each solution formed a smooth, clear film. However, as toluene was added to the solvent system and as the retarder concentration was increased, differences in film smoothness and clarity, dependent upon the retarder incorporated, were observed (see Table 3). Ethyl lactate is also an effective retarder solvent for cellulose lacquers.

Useful Solvent Systems

Table 4 contains representative coating formulations based on CA-398-3 for application by dip or knife methods. These formulas may serve as starting points for the development of formulations containing modifiers suitable for specific applications. The addition of certain modifying ingredients may require some adjustment in the basic solvent system.

Table 3
Effect of Retarder Solvents on Solution Viscosity of CA-398-3 (15% ester concentration)

Solvent System, Wt %			Solution Viscosity, cP (mPa·s) @ 25°C, With Indicated Retarder Solvent								
Acetone: *Tecsol* 3 (95%) Ethyl Alcohol 90:10	Toluene	Retarder Solvent Level	Ethylene Glycol Monoethyl Ether	*Eastman* EP Solvent	*Eastman* PM Solvent	Ethylene Glycol Monoethyl Ether Acetate	*Eastman* PM Acetate	*Eastman* EEP Solvent	Diacetone Alcohol	Cyclo-hexanone	1-Nitro-propane
100	—	—	270	270	270	270	270	270	270	270	270
90	—	10	290	335	330	350	335	340	305	320	270
80	10	10	315	390	355	325	380	400[a]	395	320	315[a]
60	30	10	450[a]	495[b]	460[a]	620[b]	550[b]	570[b]	605	520[b]	490[b]
60	20	20	550	520[a]	480	560[a]	540	600[b]	585	550	475[a]
40	30	30	900[a]	—[c]	740	1,550[c]	—[c]	—[c]	1,050[a]	1,000	—[c]

[a]*Slight haze in film* [b]*Opaque film* [c]*Grainy lacquer*

Table 4
Basic Formulations Suggested for Practical Coating Applications of CA-398-3

	Application Method		
	Dip, Fast Evaporation	Knife, Slow Evaporation	Knife, Slow Evaporation
Component	**Composition, Wt %**		
CA-398-3	10.0	15.0	15.0
Acetone:*Tecsol* 3 (95%) ethyl alcohol (90:10)	90.0	42.5	42.5
Toluene	—	25.5	25.5
Eastman PM glycol ether	—	17.0	—
Diacetone alcohol	—	—	17.0
	100.0	100.0	100.0
Viscosity			
Viscosity, *Brookfield,* @ 25°C, cP (mPa·s)	42	680	580
No. 4 *Ford* Cup, s	23	190	175

Plasticizer Compatibility

For most of the diversified uses of cellulose acetate, plasticizers are incorporated into the coating to improve flexibility. Other desirable changes in properties, e.g., changes in electrical characteristics, flammability, and resistance to moisture and weathering, can be a result of plasticizer addition.

The solubility of cellulose acetate in plasticizer often determines the practical usefulness of the plasticizer. Table 5 provides data on the solubility and compatibility of a number of common plasticizers with cellulose acetate. In general, solvent-type plasticizers provide greater compatibility and film flexibility, whereas nonsolvent types are usually more effective in maintaining tensile strength and abrasion resistance of the film.

An additional factor to be considered is the permanence of the plasticizer during aging. Table 6 shows data obtained from three different types of plasticizer-retention studies. As the results indicate, many of the compatible materials are inferior in permanence because they are rapidly lost from the film during outdoor exposure or accelerated-aging tests.

Table 5
Solubility and Compatibility Data for Various Plasticizers[a]

	Solubility in Plasticizer[b]		Maximum Plasticizer Content[c]		
Plasticizer	**25°C**	**180°C**	**Clear Films**	**Retained After Curing**	**Permanent Compatibility During Aging**
Butyl phthalyl butyl glycolate	I	I	60	60	50
Eastman DBP (dibutyl phthalate)	I	I	30	30	30
Eastman DEP (diethyl phthalate)	I	S	90	85	30
Eastman DMP (dimethyl phthalate)	S	S	100	85	15
Ethyl o-benzoylbenzoate	I	S	50	50	50
Ethyl phthalyl ethyl glycolate	I	S	100	100	40
Methyl o-benzoylbenzoate	I	S	70	70	55
Methyl phthalyl ethyl glycolate	S	S	100	100	40
Eastman triacetin	S	S	100	95	12
Tributyl citrate	I	I	50	50	30
Tributyl phosphate	I	S	80	70	17
Tricresyl phosphate	I	I	30	25	20
Triphenyl phosphate	I	I	50	35	30
Eastman tripropionin	I	S	90	80	25

Code: S—Soluble; I—Insoluble

[a] *Fordyce and Meyer,* Ind. Eng. Chem., *32, 1058–9 (1940).*
[b] *Solubility of 1 gram of cellulose acetate in 10 grams of plasticizer.*
[c] *Plasticizer content expressed as parts plasticizer/100 parts cellulose acetate.*

The maximum plasticizer content in Table 5 is of special significance. The first value represents the maximum amount of plasticizer yielding clear films after solvent evaporation. The second value denotes the maximum amount of plasticizer retained in the film after complete curing. The third test value indicates the maximum amount of plasticizer for permanence in most practical uses. This third value was determined from water immersion data shown in Table 6. As a comparison of the three values indicates, it is generally advisable for most applications to use plasticizer concentrations well below the maximum values to avoid the disadvantages that result from a rapid initial plasticizer loss.

Table 6
Retention of Plasticizers by *Eastman* Cellulose Acetate During Aging[a]

Plasticizer	Initial Film	Plasticizer Content (parts plasticizer/100 parts cellulose acetate)												
		Outdoor, Roof (Aug.–Nov.)					Oven, 100°C				Water Bath, 40°C			
		20 h	60 h	1 wk	1 mo	3 mo	20 h	60 h	100 h	160 h	20 h	60 h	100 h	160 h
Butyl phthalyl butyl glycolate	55	55	55	54	53	51	–	24	18	12	49	39	34	28
Eastman DBP (dibutyl phthalate)	32	32	31	30	28	11	20	19	18	17	29	27	26	25
Eastman DEP (diethyl phthalate)	53	41	36	32	30	26	21	18	18	17	26	22	19	14
Eastman DMP (dimethyl phthalate)	42	29	27	25	24	20	16	14	13	12	17	11	8	6
Ethyl o-benzoylbenzoate	60	59	59	58	Brittle	–	40	31	28	26	50	46	44	39
Ethyl phthalyl ethyl glycolate	59	57	56	55	53	47	29	27	25	21	38	31	25	21
Methyl o-benzoylbenzoate	61	57	57	56	Brittle	–	36	33	32	29	52	49	46	42
Methyl phthalyl ethyl glycolate	57	54	53	52	46	43	38	31	29	27	38	29	24	18
Eastman triacetin	43	29	23	20	15	13	14	12	11	10	12	9	8	6
Tributyl citrate	62	58	56	54	50	43	32	25	24	22	34	28	27	24
Tributyl phosphate	40	28	27	23	18	15	14	13	12	12	15	14	12	9
Tricresyl phosphate	21	21	20	18	18	17	20	19	18	17	18	18	18	17
Triphenyl phosphate	31	29	29	29	28	28	26	23	22	21	27	26	24	23
Eastman tripropionin	55	39	37	34	27	23	19	17	16	14	21	17	15	12

[a]*Fordyce and Meyer,* Ind. Eng. Chem., *32, 1055 (1940).*

Effect of Plasticizers on Film Properties

Figure 7 illustrates the general influence of plasticizer on the physical properties of cellulose acetate films. For this study *Eastman* DMP (dimethyl phthalate), *Eastman* DEP (diethyl phthalate), triphenyl phosphate, methyl phthalyl ethyl glycolate, and ethyl phthalyl ethyl glycolate were tested in various concentrations up to 30% in 0.005-in.-thick films of CA-398-10 coated from a 90:10 blend of acetone:*Tecsol* 3 (95%) ethyl alcohol. The test values were generally within the ranges indicated in Figure 7, except for the following variations:

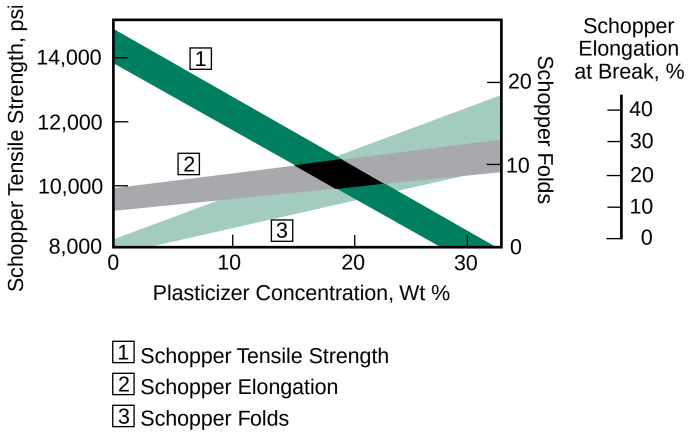
Schopper tensile strength—Films modified with triphenyl phosphate gave values above those shown in the graph. The value for *Eastman* DEP was on the high side of the indicated band.

Schopper elongation—All the plasticizers produced films with Schopper elongation values within the range shown in Figure 7. However, values for films containing *Eastman* DEP were on the high side of the range.

Schopper folds—The number of Schopper folds obtained with these plasticized films fell within the indicated range, with *Eastman* DMP and *Eastman* DEP giving the highest values.

Sward hardness—Although it is not shown in Figure 7, the Sward hardness of each film was determined. At 10% plasticizer concentration for each of the plasticizers, hardness values were above 51 (glass = 100); at 20%, above 39; and at 30%, above 33. Triphenyl phosphate gave the hardest films.

Figure 7
Effect of Plasticizer Addition on Physical Properties of CA-398-10



Chemical Resistance

Where near-chemical-inertness to attack by industrial and household chemicals and fumes is desired in a protective coating, *Eastman* cellulose acetate esters attain a special importance. As expected from their fairly limited solubility, they are unaffected by weak organic acids and show excellent resistance to greases, oils, gasoline, and similar materials. Table 7 shows resistance of unmodified films of CA-398-3 to attack by several organic and inorganic reagents.

Table 7
Chemical Resistance of Cellulose Acetate[a]

Reagent	Weight Change, % 1 Week	Weight Change, % 1 Month	Film Appearance 1 Month
Water	−8	−9	Good
10% Sodium hydroxide	Broken	Broken	—
10% Sodium carbonate	−40	−42	Fair, shrunken
10% Hydrochloric acid	−50	−53	Poor, shrunken, distorted
10% Acetic acid	−8	−8	Good
10% Nitric acid	Broken, swollen	Broken, swollen	—
10% Sulfuric acid	−39	−44	Fair, shrunken
Toluene	−3	−3	Good
Perchloroethylene	+2	+4	Good
Tecsol 3 (95%) ethyl alcohol	−9	−9	Good
Diethyl ether	−7	−7	Good
Acetone	Dissolved	Dissolved	—
Ethyl acetate	Dissolved	Dissolved	—
10% Sodium chloride	−6	−8	Good
Dioctyl sebacate	0	−1	Good
Hydraulic fluid	0	−1	Good
Oil, SAE No. 10	−1	−1	Good
1% Detergent solution	−7	−8	Good
Sodium hypochlorite bleaching solution	Dissolved	Dissolved	—
Heptane	0	0	Good

[a]*Values were obtained by immersing unmodified films of CA-398-3 in reagents listed at room temperature for the periods noted.*

Resin Compatibility

Other resins may be incorporated into cellulose acetate protective coating formulations to increase gloss, provide a harder surface, improve adhesion, lower costs, or modify other properties, depending on the type of resin. Relatively few resins are fully compatible with cellulose acetate. Table 8 gives data on the compatibility of several commercial resins.

The classes below generally show poor compatibility at a 1:4 or 1:1 resin:ester ratio.

Variations in formulation can considerably alter resin compatibility. For instance, variations in solvent combination or incorporating a mutually compatible plasticizer may improve resin compatibility in some cases. Any particular resin should be evaluated under actual use conditions to determine its suitability for a specific application.

- Alkyds (all types)
- Amino resins
- Cellulose acetate butyrate
- Chlorinated paraffins
- Chlorinated rubber
- Elastomers
- Ester gum
- Ethylcellulose
- Hydrocarbon resins
- Methacrylic polymers and copolymers
- Natural resins
- Phenolic resins
- Polyamides
- Polystyrene
- Polyvinyl acetal
- Polyvinyl butyral
- Polyvinyl formal
- Shellac
- Vinyl copolymers

Table 8
Compatibility of Various Resins With CA-398-3

Resin	Compatibility[a] 1:4[b]	Compatibility[a] 1:1[b]	Type of Resin	Supplier
Methylon 75-108	SI	I	Phenolic	Oxychem
RS ½-s nitrocellulose	C	C	Cellulose nitrate	Aqualon
Ketjenflex MH	C	C	Arylsulfonamide formaldehyde	Akzo Chemie America
Vinsol, pulverized	SI	SI	Wood rosin fraction	Aqualon
AYAC	C	I	Polyvinyl acetate	Union Carbide
Cymel 300	C	SI	Hexamethoxymethyl melamine	Cytec

[a]*C—Compatible; SI—Slightly Incompatible; I—Incompatible*
[b]*Ratio of resin to cellulose ester at 20% nonvolatile content in the following solvent system:*

	Wt %
Acetone	*67*
Diacetone alcohol	*10*
Tecsol *3 (95%) ethyl alcohol*	*8*
Toluene	*15*
	100

Applications

The combination of properties offered by *Eastman* lacquer-type cellulose esters makes them useful in a number of coatings applications (see Table 9). Representative formulations for these coatings are given on the following pages.[1]

Cellulose acetate esters are also used to advantage in several special applications, such as the preparation of dopes and cements for model airplanes, lacquers for electrical insulators, wood sealers, flow-retarder agents in paint removers, mold release agents, barrier and release coatings for pressure-sensitive tapes, and specialty adhesives.

[1] *Formulations contained in this publication are given for illustrative purposes. Eastman makes no representations as to the suitability of its products for any formulation or the suitability of any formulation for any particular end use.*

Coatings for Paper

Because of its excellent grease and oil resistance, cellulose acetate is widely used in coatings for paper products. Its high melting point and physical strength also contribute to its usefulness with these materials. Its freedom from odor and taste is important in the coating of items such as paper plates, cups, and food packaging material. Table 10 gives a representative formulation for this application.

Table 9
Uses and Characteristics of Cellulose Acetate Coatings

Uses	Characteristics
Lacquers for paper	Excellent grease and oil resistance, high melting point, physical strength
Lacquers for glass	Toughness, clarity, high melting point
Lacquers for plastics	Toughness, high surface gloss, color possibilities
Lacquers for wire screen	Transparency, weather resistance, good clarity and color retention after long exposure to ultraviolet light
Release coatings	Low compatibility with other coatings

Table 10
Paper Coating Formulation

Component	Wt %	Kg/100 L	Lb/100 Gal
CA-398-10	18.0	15.875	132.48
Eastman triacetin plasticizer	4.5	3.969	33.12
Toluene	9.0	7.937	66.24
Acetone	52.0	45.861	382.72
Methyl alcohol	9.5	8.378	69.92
Diacetone alcohol	7.0	6.174	51.52
	100.0	88.194	736.00

Nonvolatile: 22.5 wt %
Viscosity: *Brookfield*, 3,700 cP (mPa·s)

Coatings for Glass

Cellulose acetate is widely used in coatings for flashbulbs and colored light bulbs. On flashbulbs, the coating forms a protective layer that helps retain the glass under the force generated when the bulb is flashed. The high melting point, low flammability, and good light characteristics of cellulose acetate are of value in this type of application.

Light bulbs may be colored by adding dye or pigment to the acetate lacquer. The coating withstands heat from the bulb without becoming tacky and retains its film integrity for a long time.

Table 11 gives a representative coating formulation for flashbulbs or colored light bulbs.

Coatings for Plastic

Tough, durable surfaces with improved appearance may be imparted to plastic materials through application of cellulose acetate lacquers. These coatings are useful in covering machine marks and giving a higher surface gloss. Decorative effects may be obtained by using pigmented lacquers. In many instances, greater color variation is possible using pigmented lacquers than through direct pigmentation of the plastic material. Cellulose acetate lacquers can also be used in printing operations on plastic substrates. An ultraviolet-screening additive aids in protecting the substrate.

Table 12 gives a representative lacquer formulation for use on cellulose acetate plastic. The coating can be pigmented to obtain a desired color.

Table 11
Glass Bulb Coating Formulation

Component	Wt %	Kg/100 L	Lb/100 Gal
CA-398-6	17.0	14.667	122.4
Eastman DBP plasticizer	0.5	0.431	3.6
Acetone	59.5	51.407	429.0
Tecsol C (anhyd) ethyl alcohol	14.5	12.534	104.6
Diacetone alcohol	8.5	7.346	61.3
	100.0	86.385	720.9

Nonvolatile: 17.5 wt %
Viscosity: *Brookfield*, 970 cP (mPa·s)

Table 12
Plastic Coating Formulation

Component	Wt %	Kg/100 L	Lb/100 Gal
CA-398-3	7.0	5.972	49.84
Eastman triacetin plasticizer	2.0	1.706	14.24
Acetone	35.0	29.862	249.20
Methyl ethyl ketone (MEK)	15.0	12.798	106.80
Methyl isobutyl ketone (MIBK)	8.0	6.825	56.96
Tecsol C (95%) ethyl alcohol	8.0	6.825	56.96
Toluene	15.0	12.798	106.80
Eastman PM acetate	10.0	8.532	71.20
	100.0	85.318	712.00

Nonvolatile: 9.0 wt %
Viscosity: *Brookfield*, 30 cP (mPa·s)

Coatings for Wire Screen

The transparency of cellulose acetate coatings and their ability to transmit sunlight, particularly beneficial ultraviolet rays, have led to their extensive use on wire screening for greenhouse windows, poultry houses, and similar structures. The good physical strength of the coating results in tough windows. Highly resistant to weathering, cellulose acetate coatings show good clarity and color retention after long exposure to ultraviolet light. Table 13 provides a representative formulation.

Release Coatings

Because of its restricted solubility and compatibility, cellulose acetate is often used in coatings on paper to provide release properties for tapes and decals. Release properties of such a coating can be further improved when cellulose acetate is combined with a melamine resin in a curing system. Table 14 gives a representative starting formulation for this type of release coating.

Table 13
Wire Screen Coating Formulation

Component	Wt %	Kg/100 L	Lb/100 Gal
CA-398-10	16.0	14.015	116.96
Triphenyl phosphate	2.0	1.752	14.62
Eastman triacetin plasticizer	2.0	1.752	14.62
Acetone	52.0	45.549	380.12
Diacetone alcohol	8.0	6.528	58.48
Toluene	10.0	8.760	73.10
Methyl alcohol	10.0	8.760	73.10
	100.0	87.116	731.00

Nonvolatile: 20.0 wt %
Viscosity: *Brookfield*, 2,000 cP (mPa·s)

Table 14
Release Coating Formulation

Component	Wt %	Kg/100 L	Lb/100 Gal
CA-398-6	18.5	16.227	135.42
Cymel 300 resin[a]	1.5	1.316	10.98
Acetone	59.2	51.927	433.34
Tecsol C (anhyd) ethyl alcohol	10.0	8.772	73.20
Diacetone alcohol	10.0	8.772	73.20
pTSA catalyst[b]	0.8	0.702	5.86
	100.0	87.716	732.00

Nonvolatile: 20.0 wt %
Viscosity: *Brookfield*, 1,950 cP (mPa·s)
Drying conditions: Force-dry at 135°C (275°F) for 10–20 seconds

[a] *Cytec*
[b] *50:50 p-toluenesulfonic acid:n-butyl alcohol*

Safety Precautions

For safety information, see Eastman Publication E-241, *Handling Precautions for Cellulose Esters in Formulating Coatings*. Material Safety Data Sheets providing safety precautions to be observed in handling and storing Eastman products are also available on request. You should obtain and review these publications before handling any of these products. If any materials mentioned are not Eastman products, appropriate industrial hygiene and other safety precautions recommended by their manufacturers should be observed.

FDA Status

Food additive regulations issued by the United States Food and Drug Administration permit use of cellulose acetate in the following specific food packaging applications subject to any limitations in the regulations:

21 CFR 175.300	Resinous and Polymeric Coatings
21 CFR 175.380	Xylene-Formaldehyde Resins Condensed With 4,4′-Isopropylidenediphenol-Epichlorohydrin Epoxy Resins
21 CFR 175.390	Zinc-Silicon Dioxide Matrix Coatings
21 CFR 176.170	Components of Paper and Paperboard in Contact with Aqueous and Fatty Foods
21 CFR 177.1210	Closures With Sealing Gaskets for Food Containers

Additionally, cellulose acetate is “prior sanctioned” under the federal Food, Drug and Cosmetic Act for use in film in food contact applications. Cellulose acetate is also recognized by FDA as “generally recognized as safe” (GRAS) for use in paper and paperboard in contact with food under 21 CFR 182.90. The FDA has proposed to issue a regulation affirming GRAS status for the use of cellulose acetate meeting proposed specifications in films and filters in food contact applications. When issued, the proposed regulation would delete the clearance under 21 CFR 182.90.

Any plasticizer, colorant, or other additives used with cellulose acetate must also be lawful for use in the specific application. Eastman Publication L-160 provides information on the use of *Eastman* plasticizers under FDA food additive regulations and is available upon request.

It is the responsibility of users to determine that *Eastman* cellulose acetate is safe, lawful, and technically suitable in its intended application. Because of possible changes in the law and in regulations, as well as possible changes in our product, we cannot guarantee that the status of this product will remain unchanged. Therefore, we recommend that customers continuing to use this product verify its status no less frequently than every two years from the date of this publication.

Material Safety Data Sheets providing safety precautions that should be observed in handling and storing Eastman products are available on request. You should obtain and review the available material safety information before handling any of these products. If any materials are mentioned that are not Eastman products, appropriate industrial hygiene and other safety precautions recommended by their manufacturers should be observed.

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EASTMAN CHEMICAL COMPANY
World Headquarters
P.O. Box 431
Kingsport, TN 37662-5280
U.S.A.

Telephone:
U.S.A. and Canada
800-EASTMAN (800-327-8626)

Other Locations
(1) 423-229-2000

Technical Service Centers Outside U.S.A.

Liverpool, England
(44) 161-927-8220

Osaka, Japan
(81) 6-993-8340

http://www.eastman.com

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