Heat sealing film and sheet
made of Eastman copolyesters

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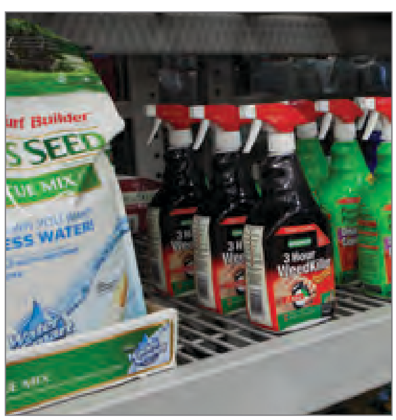
Eastman Chemical Company manufactures copolyesters that can be extruded into film or sheet and subsequently thermoformed or fabricated into various containers. Most packages must be closed in some way, and the vast majority are closed by heat sealing. Mechanical integrity of the seal is a primary consideration, and requirements are based on the intended end use. For example, seals need to survive stresses incurred during distribution and handling. Some seals need to be as strong as the rest of the package, and these are termed destructive seals. When the package is placed under stress to failure, the failure occurs at a location other than at the seal interface. In other cases, a peelable seal is designed for easy-opening packages so that the strength of the interface is less than that of the bulk package material and failure occurs at the interface. Peelable seals usually require multilayer package constructions.

In some applications, the seal must have sufficient hot-tack strength to survive application of stress immediately after sealing but before the seal area has had a chance to cool. Also, because it is difficult to precisely control the temperature in the seal area with some commercial sealing equipment, an adequate seal should be obtained over a wide temperature range. The range is bounded on the low-temperature side by the seal initiation temperature and on the high side by the temperature that distorts or destroys the package. Both hot-tack strength and seal temperature range can be improved by using multilayer package construction.

Seals for food or medical packages may need to be hermetic—that is, the seal must prevent the transmission of microorganisms into the package. Not only should the seal be strong, but the sealing equipment should be designed to minimize film wrinkling or air entrapment.

Sealing methods and the use of Eastman's copolyesters are detailed in this brochure and include:

- Heated-bar sealing
- Impulse sealing
- Radio frequency (RF) sealing
- Blister board heat-seal coatings
- Peelable lidding films



Heated-bar sealing

The hot-bar method of heat sealing is accomplished by pressing the films to be sealed between a heated upper bar and an unheated lower bar with a sealing pad or gasket (usually silicone rubber) with a Shore A hardness of 60–70. Temperature and pressure as well as dwell or seal time are controlled.

Variables

Sealing bars—Typically, only the top bar is heated; however, in some cases, upper and lower bars can be heated. A release covering such as impregnated fiberglass cloth is typically used on the heated bar and pad to protect their surface.

Dwell or seal time—The time heat and pressure are applied to the substrates to be sealed to complete the bond

Sealing pressure—Air pressure is typically applied to a cylinder that closes the upper and lower bars. More precise pressure can be accomplished using a mechanically driven step motor instead of an air cylinder, although it is slower.

The advantages of the hot-bar sealing method are the speed at which seals can be made (Table 1) and the relatively low cost of machinery.

Table 1

Typical heated-bar sealing conditions[a] for Eastman copolyester films

Film	Gauge, mils	Temp, °F	Dwell, s	psig
Eastar™ copolyesters				
6763, PETG	2 to 2	260	1	60
	2 to 10	300	1	60
	10 to 10	310	1	60
Eastar™ PCTG				
25991	2 to 2	275	1	60
	2 to 10	275	1	60
	10 to 10	360	1	60
Eastapak™ copolyesters				
9921, APET	2 to 2	260	1	60
	2 to 10	275	1	60
	10 to 10	365	1	60
Eastman Eastobond™ copolyesters				
19411, 19412	2 to 2	160	1	60
	2 to 10	200	1	60
	10 to 10	270	1	60
Eastman Tritan™ copolyesters				
MP100, FX100, HX100	2 to 2	265	1	60
	2 to 10	285	1	60
	10 to 10	300	1	60

[a] *Upper and lower jaws heated to produce a destructive seal. Sentinel heat sealer, ¼ in. X ¼ in. seal area, and heated top and bottom Teflon™ coated flat bar*

Impulse sealing

Impulse sealing is a process of welding thermoplastic films by heating with a short, powerful impulse and cooling while still under pressure. A typical thermal-impulse sealer consists of a pair of jaws containing a heater element, usually a metal strip. After the jaws are closed, short intermittent electrical impulses are applied to the heater element, instantaneously heating the films to their welding temperature. After a short cooling time under pressure, the seal is complete.

Variables

Power setting—Power is applied to a resistance metal strip which instantly heats the upper and/or lower jaw. This strip can be of various widths and lengths, depending on the bond desired. The voltage/amperage is adjustable.

Sealing pressure—Air pressure applied to the jaws

Dwell or seal time—The time heat and pressure are applied

Cooling time—The time the seal is held in place for the bond to solidify

Typical impulse-sealing conditions needed to produce a destructive seal are shown in Table 2.

Table 2

Impulse-sealing comparison of 10-mil[a] Eastman copolyester films

		Dwell time, s		
Film	**Jaws**	**20 V (18 amps)**	**30 V (24.5 amps)**	**40 V (30 amps)**
Eastar™ copolyester 6763	Upper jaw	2.0	1.2	0.7
	Both jaws	1.5	1.0	0.5
Eastar 25991	Upper jaw	2.5	1.5	0.7
	Both jaws	1.5	1.0	0.7
Eastapak 9921	Upper jaw	3.5	2.0	1.0
	Both jaws	2.2	1.0	0.7
Eastobond 19411 or 19412	Upper jaw	1.5	1.0	0.5
	Both jaws	1.2	0.7	0.4
Tritan MP100, FX100, HX100	Upper only	3.2	2	0.7
	Both jaws	2.7	1.2	0.7

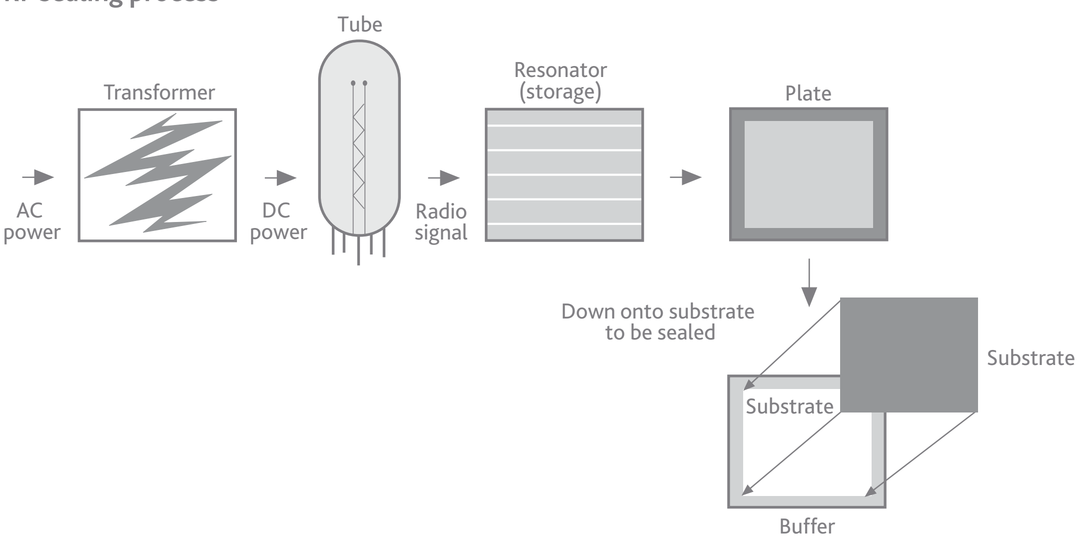
[a]*Films sealed to themselves to obtain destructive seal using air pressure of 0.28 MPa (40 psi) and 1 second cooling under pressure. 10-mil Sentinel impulse sealing and 1 in. X ⅛ in. seal area*

Radio frequency sealing

Radio frequency (RF) sealing, or dielectric sealing, uses radio waves to activate the molecules in the areas to be sealed, generating heat for sealing purposes. The copolyester films being sealed act as a resistor, creating heat, and also act as a capacitor, storing or holding heat. It is easier to seal thicker films because there is more mass to build and store heat; thinner films require more power to obtain the desired seal.

Figure 1

RF sealing process



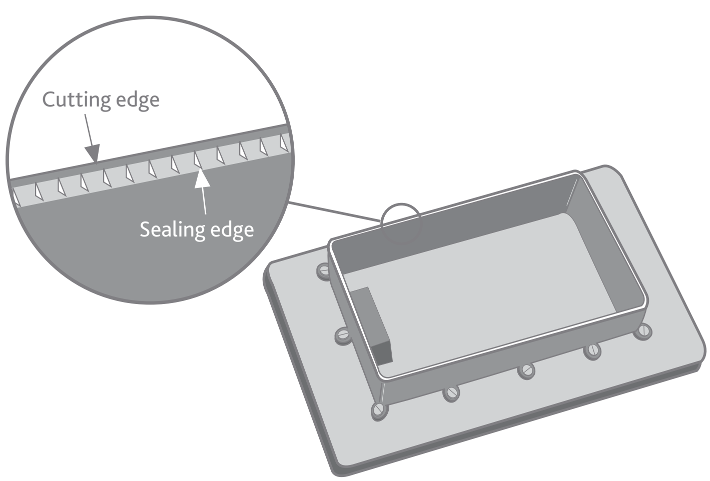
RF sealing is used with copolyester films for clamshell and blister packaging. In addition, RF sealing can be used to make tear seals by sealing a blister to backer film and cutting the composite in a single operation. Because RF tear seals can be produced with virtually no flanges, these composites are frequently used to package products such as toothbrushes that are merchandised in limited rack space.

Tear seals require tooling designed for the gauge thickness and shape to be sealed and cut. The sharp outside edge of the tool is designed for cutting, whereas the inside perimeter is for sealing. Some adjustment may be necessary in preseal, seal, and cooling time, as well as RF power, when changing film thickness or material.

Additives can be used in films to make them more active or receptive to RF sealing; however, they do reduce clarity.

Figure 2

Tear seal die



Variables

- Preheating the press plate and/or tool is suggested to reduce heat loss and raise the temperature of the plastic.
- Sufficient force must be applied for proper operation of the press and to provide the cutting action on tear seal or seal-and-cut operations.
- The time needed for the force applied to push the tool into contact with the film before the RF power is applied
- RF energy is applied during this time to soften the copolyester. The press then forces the die into the copolyester, creating the seal.
- The time used to hold the seal in place until the bond solidifies
- The power setting depends on the size of the machine and power available. A 10-kW machine would typically be run at approximately three-quarters power to seal and cut two 0.25-mm (10-mil) copolyester films. Typical plate current and grid current meter readings are 0.5 amps and 0.4 amps, respectively.
- Phenolic impregnated cloth, biaxially oriented PET, and proprietary insulating sheets are suitable materials used as a buffer or as insulation.

Typical RF tear seal conditions for 0.25-mm (10-mil) films of Eastman copolyesters are shown in Table 3. Trim that could easily be removed resulted from these conditions.

Table 3

Radio frequency sealing conditions for Eastman copolyesters

	Eastar 6763	Eastar 25991	Eastapak 9921	Tritan MP100, FX100, HX100
Preseal, s	1	2	1	1
Seal, s	1	2	2	1.8
Cool, s	1	0.5	1	1
Plate temperature, °F	250	250	250	250
RF power, %	80	80	80	80
Pressure, psig	80	80	80	80
Seal quality	Good	Good	Good	Good
Cut quality	Good	Good	No	No

[a]Using a 10-kW Kabar, 27.12-MHz RF sealer, 0.25-mm (10-mil) films of Eastman copolyesters were sealed to themselves.

Blister board heat-seal coating

Blisters made from Eastman copolyesters can be sealed to typical blister board. An adhesive coating is applied to the blister board after printing; heat is usually applied through the blister board to activate the adhesive coating and seal to the blister flanges. Commercial solvent and water-based coatings are available for application to various board stocks.

Typical conditions for acceptable fiber tear sealing of copolyester blisters with a 0.25-mm (10-mil) thick flange to a suitably coated board stock are 150°–205°C (300°–400°F), 3 to 4 seconds dwell time, and 0.41 MPa (60 psi) of pressure.

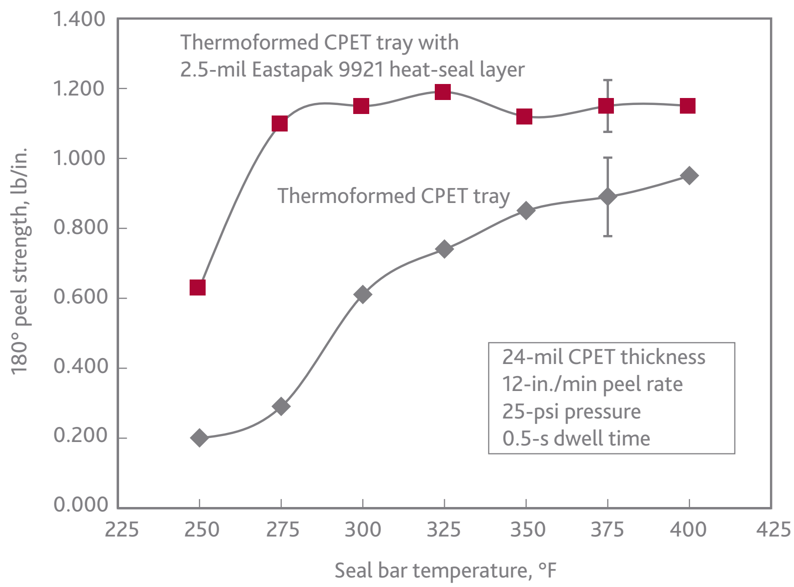
Silicone coating of the blister film can lower bond performance. The addition of antiblock or denest additive concentrates to Eastman copolyesters when extruding the blister film produces acceptable bond performance with many blister board coatings.

Peelable lidding

Commercial lidding materials with preapplied heat-seal layers that provide peelable seals of varying strengths for use on thermoformed containers made of Eastman copolyesters are available. A heat-seal layer of Eastapak 9921 may be coextruded onto CPET to produce dual-ovenable thermoformed containers that provide higher peel strengths and a lower seal initiation temperature when sealed to typical commercial lidding films.

Figure 3

Heat sealing a typical OPET lidding film to thermoformed CPET tray—Benefits of an Eastapak 9921 heat-seal layer



Typical sealing conditions for commercial lidding materials are 105°–135°C (225°–300°F), 0.5 second dwell time, and 0.17 MPa (25 psi). Commercial peelable lidding films include Mylar® lidding films from DuPont and films from Rollprint.

Rigid medical packaging

Commercial liddings made from DuPont's Tyvek® with preapplied heat-seal layers are available, providing peelable seals with uniform adhesive transfer on thermoformed packaging made of Eastar copolyesters. Typical sealing conditions are 127°–132°C (260°–270°F), 1–2 seconds dwell time, and 0.28–0.62 MPa (40–90 psi).

Conclusion

Eastman copolyesters are versatile plastics for many packaging and fabricating applications and can be heat sealed using several different methods.

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