DuPont Packaging & Industrial Polymers

Easing Your Way to Reliable Peelable Seals

WHITE PAPER

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Introduction

Packaged goods manufacturers are meeting consumer demand for easy opening packages by adopting peelable seals for more and more products. The consumer may have no interest in the details of a package but has shown keen interest in ease of use.

In satisfying the consumer's desire, packagers and converters have to make sure that seals not only open easily but also seal effectively to protect the product as it moves along the distribution chain.

Packaged goods manufacturers have risen to the challenge in adopting easy-open packages for a wide range of products. Major application categories include:

- Processed meats and cheese: bacon, hot dogs, sliced deli meats, cheese in various formats
- Bag-in-box liners: cereal, snacks, crackers, cookies
- Container lidding: yogurt, snack canisters, frozen meals and more
- Medical products of various kinds

This paper can help you better understand and deal with the challenges of designing and making easy opening packages. It defines peelable seals, describes separation mechanisms and discusses considerations in choosing a sealant. A major part of it outlines the extensive range of materials DuPont offers for peelable seals and discusses how they meet different requirements for various kinds of packages and product contents.

The ABCs of Peelable Seals

Opening Modes

Peelable seals can open in one of three ways:

- **Interfacial Separation**. The seal opens at the seal interface (***Figure 1***), and sealing temperature is a key determinant of the seal strength of a given material.
- **Delamination**. The structure separates at an internal interface, i.e. between the seal layer and an inside layer or between inside layers. Layer thickness and adhesion between internal layers determines peel strength.

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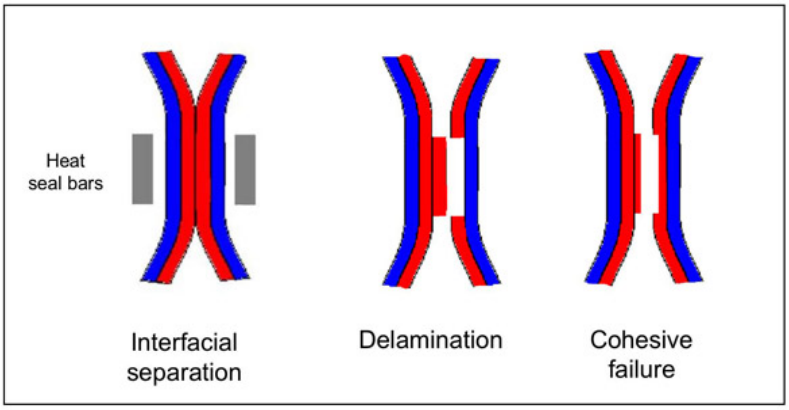
- **Cohesive Failure**. The structure separates within the seal layer (***Figure 1***). The material's inherent strength determines the force required for separation.

Cohesive failure can serve as evidence of product freshness or of tampering, particularly if the separating layer is formulated to stress-whiten when pulled apart. Many medical packages use this kind of peelable seal, but food products do as well.

Figure 1.

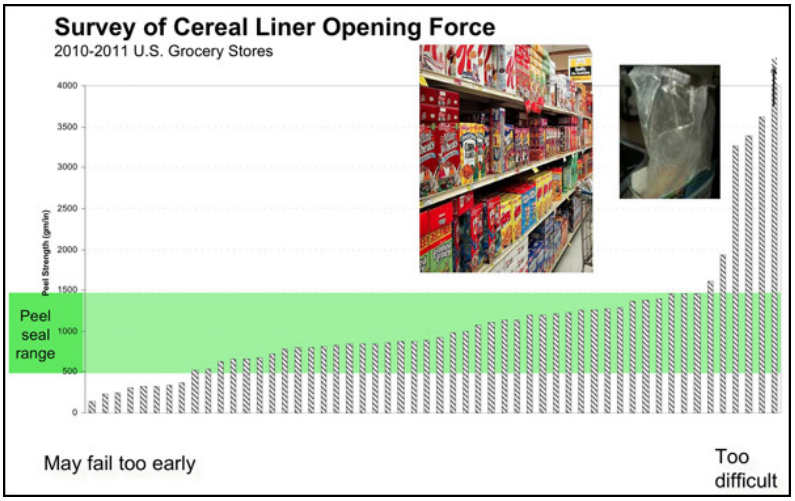


Opening Force

Several factors besides the sealant's strength and sealing temperature affect opening force for a peelable seal. They include:

- Stiffness of the total structure
- Burst strength of the structure
- Angle of peel
- Elongation of the sealant
- Surface area of the seal
- Sealing jaw pattern
- Packaging conditions (temperature, line speed)
- Aging

Figure 2.



The influence of aging factors and packaging conditions means that measurements of opening force can vary depending on when it is measured.

The obvious goal is that the package bought by the consumer should have no open seals and be easy to open. Quite often that is not the case according to a recent DuPont survey of cereal liners. Acceptable peel strength for such packages should range from 500 to about 1500 g/in. Measurements of the seal strength of samples taken from store shelves showed that 26% of them fell outside the range with 15% too weak and 11% too strong (***Figure 2***).

Choosing a Peelable Sealant

Many sealant materials are available, and most of them can somehow be adapted for peelable seals. In choosing one for a particular package, the best method is to start by asking what the sealant must do, pick an appropriate material and then add peelability. Key considerations for choosing sealants are listed below:

- Cost
- Seal initiation temperature
- Abrasion resistance
- Stiffness
- Toughness
- Hot tack
- Process/filling equipment
- Oil/grease barrier
- Organoleptics
- Food contact acceptance
- End use conditions
- Seal around contamination
- Optics
- Caulking

Freedom to Operate

Patents cover a great deal of peel seal technology for films. In choosing materials and processes for particular packages, we strongly recommend thorough patent research to determine freedom to operate.

Material Options

The most common options for producing peelable seals are as follows:

- Use of a two sealants, a different one on each of side of the interface
- Coatings or lacquers.
- Tie layers in multilayer structures with adhesion tailored to delaminate.
- Seal layer blends in which two incompatible resins provide lower seal strength by reducing the effective seal area.

Examples of DuPont polymers that can be blended for peelable seal layers include:

- DuPont™ Elvax® EVA and polybutene
- DuPont™ Surlyn® ionomer and polybutene
- Surlyn® and Elvax®
- Surlyn® and Bynel® adhesive resins
- Custom-formulated sealants using combinations of a non-polar polymer (PE, mPE, PP for example) with a polar polymer (EVA, acid copolymer, ionomer, etc.) and possibly additives such as a slip agent.
- Resins formulated for cohesive failure, including tamper-evident types

Aging

Seal strength may change over time due to changes in these aspects of the sealant:

- Crystallinity
- Adhesion
- Morphology, primarily an issue in polybutene blends

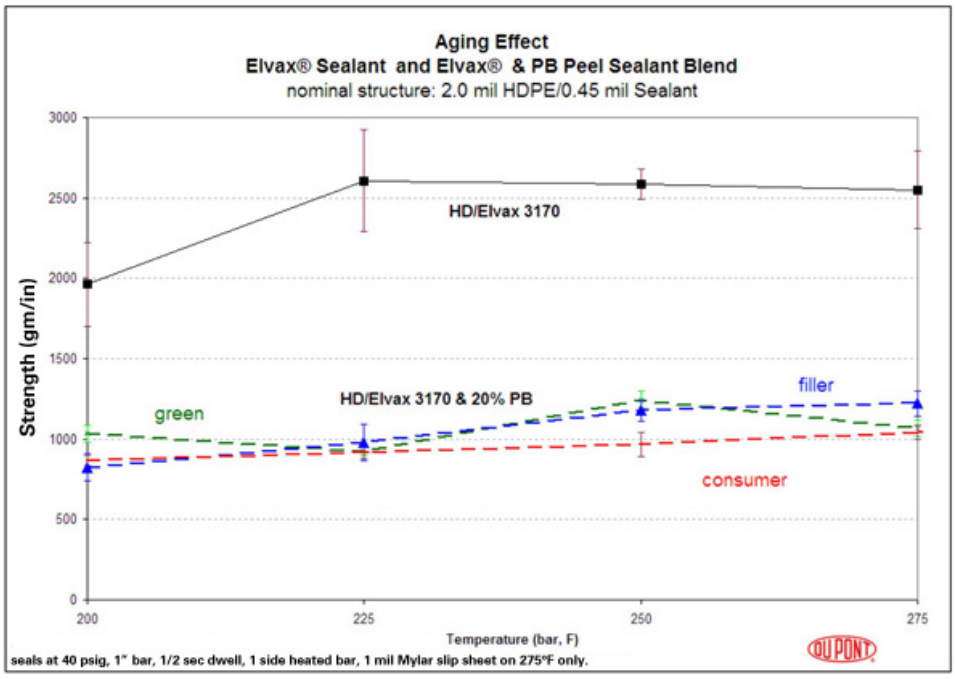
Age changes the morphology of polybutene, causing a drop in strength and a rise in seal initiation temperature. In blends, the greater the polybutene content, the greater the effect of aging on seal strength. Blends of mPE with polybutene and of EVA with polybutene age significantly because they can contain 20% polybutene or more. By contrast, blends of Surlyn® ionomer with polybutene suffer much smaller aging effects because only a small amount of polybutene is needed to make a peelable seal.

DuPont™ Elvax® EVA as a sealant. This polymer is valued as a sealant for its combination of:

- Low sealing temperature, as low as 70°C
- Clarity
- Toughness over a wide temperature range, particularly at low temperature
- Relatively low cost

It is feasible to make peelable seals with Elvax® by blending it with polybutene (PB). However, the seal strength of such blends changes significantly with age, as shown in ***Figure 3***.

Figure 3



The chart plots seal strength versus sealing bar temperature of Elvax® with 20% polybutene at three points in time: 1) in the green state on the day of manufacture, representing a converter's test result; 2) after 14 days, representing a packager's test upon sealing and filling; and 3)

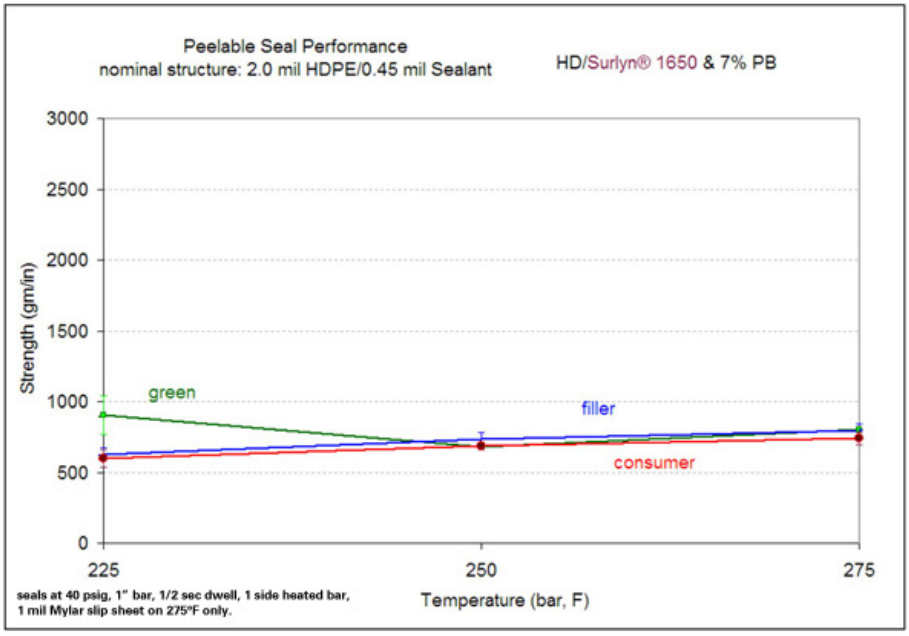
after 28 days, representing consumer experience. Although the three measurements are quite close within a narrow band of sealing bar temperatures, they diverge widely outside the band. Since sealing bar temperatures are known to vary widely on packaging lines, it is reasonable to expect considerable variations in seal strength in actual practice.

DuPont™ Surlyn® as a sealant. Ionomer resins are highly valued as sealants, particularly for their combination of:

- Seal strength stability over time
- Oil and grease resistance
- Ability to seal around/through contamination
- Sealing reliability thanks to their hot tack strength over a broad temperature range and low seal initiation temperature
- Ability to caulk gussets and fins

Surlyn® can make excellent peelable seals by adding a small quantity of polybutene, just 7% for the blended sealant's test results shown in ***Figure 4***. Aging effects are insignificant. The curves representing seal strength at converter, filler and consumer stages are very close together over a wide range of seal bar temperature.

Figure 4



Lidding

Rigid cups, tubs and other containers with peelable lids or cap liners are one of the largest application areas for easy-open packaging, and their use continues to grow. Such packages cater to today's on-the-go lifestyle with ready-to-use and heat-and-eat foods, and they meet the needs of people of all ages.

Major product categories for containers with peelable lids (***Figure 5***) include:

- Refrigerated products such as butter, margarine, yogurt, juice, pudding, spreadable cheese and other spreads
- Shelf-stable products such as noodles soups and ready meals (also refrigerated and frozen types)
- Non-food products such as wipes and over-the-counter drugs

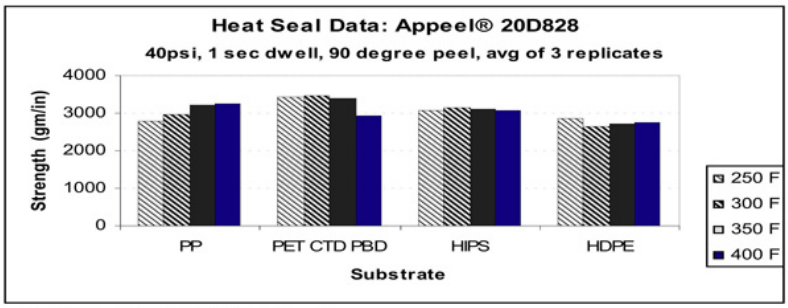
DuPont™ Appeel® lidding resins meet this market's needs for reliable sealing and controlled adhesion with a broad range of preformulated grades. The preformulated, one-bag solutions provided by Appeel® save on development time and cost, and they allow the converter to concentrate technical resources on other critical areas such as process development. Appeel® resins can produce peelable seals for any of the container substrates used today, including PP, PS, PE, PVC, PET, aluminum, epoxy, Barex® and Aclar®.

Figure 5

Appeel® resins can produce seals providing either interfacial or cohesive separation. They use several base resins including EMA, EVA and others along with additives and modifiers.

Complete information on Appeel® resins is available at www.appeel.dupont.com. Data sheets, processing recommendations, food contact compliance and other information are available there.

Figure 6



2 mil foil/0.5 mil Nucrel® 0910HS/1 mil Appeel®

Appeel® resins provide an attractive alternative to lacquer coatings. Unlike lacquers, they contain no solvents and release only negligible amounts of VOCs during processing. Converters also prefer them because they are processed using existing coextrusion equipment.

Appeel® resins have proven to provide additional benefits to converters, packagers and consumers, namely:

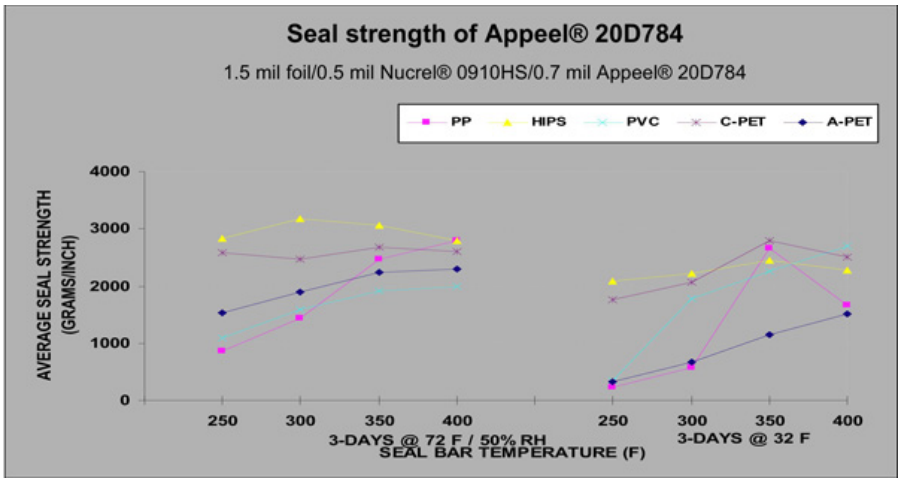
- More reliable sealing and peeling characteristics than lacquers in many applications;
- Fewer inventory items (SKUs) because most Appeel® resins work with a broader range of substrates than common lacquers;
- Replacement of aluminum foil-containing structures with paper-based or all-plastic lids that are thinner and/or less costly and that allow use of metal detection equipment for enhanced product safety.
- Low heat seal initiation temperature, possibly enabling faster speeds on packaging lines.

Three examples illustrate the benefits obtained from Appeel®:

1. **Vacuum-Resistant Seals**. Containers for products subjected to freeze-thaw cycles or hot fill require a strong yet peelable lid seal to provide vacuum resistance in order to prevent leakers during distribution. Appeel® 20D828 fills that need in sealing to a wide range of substrates (***Figure 6***), including PP, PS, PE, PVC, PET, aluminum, epoxy, Barex® and Aclar®. It also has a low seal initiation temperature and resistance to a wide range of food ingredients.

2. **Leaker Problem Eliminated**. In a recent case, switching to Appeel® solved a leaker problem with PP cups. Leakers had risen sharply when the packager switched PP suppliers, and the existing lid structure failed to seal reliably. Since the adoption of Appeel® 20D874, there have been no end- user complaints about leakers. This grade also works with several substrates (***Figure 7***).

Figure 7



3. **Retortable Packaging Solution**. One of our latest grades, Appeel® 22D843, is intended for blending with PP homopolymer or random copolymer in order to provide a peelable sealant on lids for PP trays, for sealant-to sealant-bonds or for surface layers of multilayer trays.

DuPont has successfully tested it for retort applications. The tests show that blends of PP and Appeel® 22D843 can withstand sterilization conditions from 121°C for 20 minutes up to 134°C for 6 minutes with adequate counter pressure, depending on the type of PP employed.

Appeel® 22D843 is typically blended with PP at addition rates of 20 to 40 percent by weight. The proportion of Appeel® in the blend determines peel strength. Lower addition rates result in higher peel force and vice versa.

Summary

DuPont polymers enable production of peelable seals for practically any film-to-film or film-to-container application. It is possible to engineer seals for interfacial, delamination or cohesive modes of separation. With such a wide range of solutions, DuPont does indeed ease your way to reliable easy-open packaging. To learn more about our solutions, please visit www.packaging.dupont.com.

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