

Can One Material Be Enough?

Designing Food and Consumer Packaging for Recyclability

The goal of the European Union (EU) to recycle all plastic packaging in Europe in an economically viable manner by 2030 is exerting enormous pressure on the packaging industry. It is very common that packaging films are made of different materials, and this causes challenges since they are often not easy to recycle. The demand is high for recyclable films which at the same time deliver the same or only slightly reduced food shelf life and packaging productivity. Various current examples show that this is possible.



For these stand-up pouches, counter-printed stiff PE carrier films were laminated with sealing films with low temperature sealants

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The sustainability and thus the CO₂ balance of plastic packaging must improve significantly. This can be achieved by multiple use of the involved materials. However, many currently popular packaging structures are not designed for re-

cycling. Packaging for consumer goods such as detergents, coffee and meat generally consists of several types of material such as linear low density polyethylene (LLDPE), LDPE (low density PE), HDPE (high density PE), polypropylene (PP),

polyethylene terephthalate (PET), polyamide (PA), ethylene-vinyl alcohol copolymer (EVOH) and aluminium. These materials are combined in multiple layers to protect the product with minimal material usage while ensuring product »

Fig. 1. For these dishwasher tabs packages, a film coextruded with a sealing medium and a co-extruded PE film was printed and then coated by extrusion to protect the printed image. This kind of packaging replaces combined packaging made of PET and PE © Reckitt Benckiser



quality. Usually, such multilayer and multi-material films are as thin as a human hair. The recycling of such packaging requires the separation of the different materials in order to achieve sufficient purity for recycling. This is technically possible in many cases, but very costly. An alternative approach is to develop film structures with the highest possible proportion of just one polymer. If possible, an infrastructure to recycle such material should already exist. In Europe, for example, this is the case for PE. The aim is to develop film structures that apart from the polymer mainly used do not contain other materials which would interfere with the recyclability. Whether materials turn out to be critical in a particular material recycling stream,

depends on how strongly they influence the recycling process and diminish the usability of the recyclates in further applications. Dow Europe, Horgen, Switzerland, together with various industrial partners, has developed mono-material PE-based packaging films, which continue to consist of multilayer structures but largely use one main material and, if necessary, materials compatible with the PE recycling stream.

Mono-Material Films Made of PE

The first example is dishwasher tabs packed in stand-up pouches. The packaging currently used in the market is mostly based on oriented, clear, printed polyester films, which are laminated to a coextruded PE film that serves to seal the pouch. The outer PET film with a high melting point fulfills, among others, the purpose of ensuring the stability and dimensions of the pouch during forming and sealing.

As an alternative, the concept of a mono-material film was developed that includes printing the film, which was coextruded with a low-melting sealing medium and a PE with a higher melting point, and then coating it by extrusion to protect the printed image. This allows to combine high gloss of the overall film with the high melting point of the coated PE to improve packaging machine efficiency. A reclose mechanism (zipper) was also sealed into the package. **Figure 1** shows the packaging implemented with the consumer goods manufacturer Reckitt Benckiser, Slough, Great Britain, and the packag-

ing company Drukpol, Nowy Dwór Mazowiecki, Poland.

Machine-Direction Oriented PE Replaces PET

Other examples use machine-direction oriented PE (PE-MDO) as an alternative to oriented PET film, which is characterized by high stiffness, transparency and gloss. Windmüller & Hölscher, Lengerich, Germany, produced this printed PE-MDO film which was laminated with a co-extruded PE sealing film at Dow's Pack Studios and formed into stand-up pouches suitable, for example, for liquid soaps at B&B, Hopsten, Germany (**Fig. 2**). In many applications, a good oxygen and water vapor barrier also plays a role in protecting sensitive food. As an alternative to metallized oriented PET and aluminum foils, PE-MDO films were also used in a collaboration of Dow, coating machine manufacturer Bobst, Prilly, Switzerland, Hosokawa Alpine AG, Augsburg, Germany, and the Italian company Elba, Magnago. The films served as carriers for very thin vapor-deposited barrier layers (**Fig. 3**). Biaxially oriented PE films are also being developed to serve as stiff, glossy, possibly metallized print carriers or as thin sealing films for packaging made of ideally only one material.

Externally Printed Co-Extruded Films

In addition, non-oriented, co-extruded films for use in mono-material bags have been developed in several projects. Reverse-printed stiff PE carrier films, for example, can be laminated with the above-mentioned sealing films that allow sealing at low temperatures. This concept was realized together with packaging manufacturer Transcontinental, Montreal, Canada, and the company Mespac, Santa Perpètua de Mogoda, Spain (**Title figure**). The stand-up pouches produced could be equipped with PE zippers and sealed tightly. The use of individual, externally printed coextruded PE films containing an EVOH barrier layer was implemented in collaboration with packaging manufacturer Berry Global, Evansville, IN/USA, and food company Kellogg's, Battle Creek, MI/USA (**Fig. 4**), and in another project with Georg Menshen GmbH & Co. KG, Fintentrop, Germany, and Plastiandino, San Rafael, Argentina (**Fig. 5**). In addition,



Fig. 2. Machine-oriented PE can be an alternative to oriented PET films © Dow



Fig. 3. PE-MDO films serve as a carrier for very thin vapor-deposited barrier layers © Bobst

this type of packaging can be protected with Dow's Opulux protective finishing which protects the print image on mono-material pouches.

The examples given show that in many cases it is possible to switch from currently common multi-material packaging to mono-material packaging. The

mono-material packaging concepts presented can be produced on most common packaging machine types such as vertical and horizontal form, fill and seal machines and horizontal stand-up and flat bag machines from the reel or as pre-made bags. However, adapted processing parameters must be selected. »

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Fig. 4. These stand-up pouches use externally printed co-extruded PE films. They have an EVOH barrier layer and use Retain compatibilizers for an improved recycling result of the packaging

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Fig. 5. The single material packaging is based on a single co-extruded barrier film with surface printing © Dow

In addition to the circular economy goal, the European Union has set the goal to substantially reduce food waste by 50% by 2030. So far, this waste comprises about 20% of the food produced in the EU. The shelf life of meat, for example, plays an important role in this context. Together with Kuhne Anlagenbau, Dow has helped to develop packaging that keeps meat fresh up to three times longer. Improved tough LLDPE and fast sealing plastomers are used for this purpose. At the same time, only one third to one

tenth of the material is required compared to Modified Atmosphere Packaging (MAP). Such improvements can reduce food waste along the value chain. A good example are barrier shrink films for meat, which are coextruded as multilayer films with EVOH and oriented in several steps to produce very thin and tough films. These films ensure that the packaging and thus the meat is not spoiled during transportation.

The retail packaging for meat is also being continuously optimized. Vacuum skin packaging (VSP), for example, offers the possibility of enclosing the meat cleanly and keeping it fresh with very little film use. For this purpose, a carton is covered with a thin barrier film and the meat is positioned on it. Then another thin skin barrier film is pulled over the meat like a skin by means of vacuum. For the production of this type of barrier film, Dow offers various raw materials that are tailored to the functional requirements of this kind of packaging. The latest generation of VSP films has been produced with Windmüller & Hölischer on Aquarex lines and tested at Dow on Sealpac packaging machines. For the consumer, the packaging materials are easy to separate. She or he only needs to remove the small amount of film from the carton and place both materials separately in their recycling streams.

Recycling of meat packaging is largely not practiced today from a hygienic point of view. Nevertheless, the industry is working on technologies to recycle these multilayer barrier films, which are in principle recyclable. This includes the use of compatibilizer polymers already in the film and/or during recycling. With the compatibilizer embedded in the barrier film, the improved miscibility of the barrier polymers and the PE in the films leads to good recyclate properties in secondary applications. However, an important aspect in improving the recyclability of multilayer barrier films is that the shelf life of the food must not be impaired; especially when this leads to more food waste. It is therefore important to leave room for innovations in the currently being developed guidelines for recyclable packaging design, which will allow for a continuous improvement and increase in recycling rates. Plastics are too valuable not to reuse them. ■