BRÜCKNER MASCHINENBAU
A Member of Brückner Group

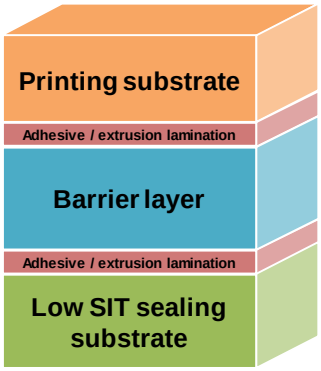
BOPE Packaging Solutions – The Next Step Towards a Circular Economy

Introduction

Today's packaging film laminates are well designed and highly engineered products. Their structures have been optimized over the last decades especially in terms of product shelf life as well as visual and haptic appearance. Already since the beginning, film producers have made great efforts in terms of downgauging – which has positive effects both from an economical but also from an ecological point of view. But recently another quality criteria for packaging film laminates came up and already became predominant: mechanical recyclability.

Technical Background

Today's packaging film laminates generally consist of different film layers which are – in most cases – made of different types of polymers. Picture 1 shows a typical structure of a packaging laminate.



Picture 1: Typical structure of a packaging film laminate

Such a laminate usually includes a printing substrate, a barrier layer and a sealing substrate. As printing substrate a biaxial oriented film made of polyester (BOPET), polypropylene (BOPP) or polyamide (BOPA) may be used. High stiffness, low shrink, a high melting point and good optical appearance are the main requirements for good printability and an attractive appearance for the end user.
The barrier layer of a packaging laminate may consist of an aluminum foil or a metallized BOPET or BOPP film. Also AlOx or SiOx coated films may be used. Task of the barrier layer is to protect the packaged food from vapor or oxygen to extend the product's shelf life or to keep the aroma inside of the packaging.

The sealing layer may be made of a polyethylene blown film or a propylene cast film. Seal initiation temperature (SIT) should be low and high toughness is favorable for proper sealing strength.
As a result of the use of different types of polymer films at the end of a mechanical recycling process there is a mixture of aforementioned raw materials, which are not easy extrudable to another high end packaging film. In other words: the mechanical recyclability of today's packaging film laminates is poor.
Chemical recycling might be an alternative path of recycling in the future where also multi-material laminates could be processed into highly pure raw materials on a molecular level.
Disadvantages of the chemical recycling process are:

- high energy consumption and thus high processing costs
- missing availability of chemical recycling systems in industrial scale

Because of that the broad application of the chemical recycling process is limited so far.

Brückner R&D

Thus from a today's point of view the mechanical recycling process is the most promising path to reuse packaging films and therefore also the most promising approach to reduce landfilled plastic waste in the future.

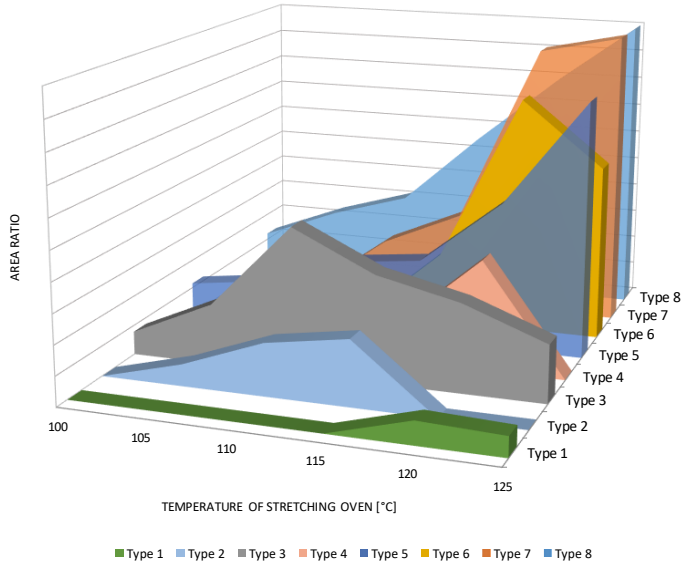
In order to improve the mechanical recyclability of packaging film laminates mono-material solutions are preferred – or even required.

All-PET or all-PP mono-material packaging solutions are principally possible, but drawbacks in terms of puncture resistance and sealing properties may be found.

The most promising mono-material approach from a today's point of view seems to be an all-polyethylene solution. Brand owners, resin suppliers, film producers and film converters are pushing the development of PE based mono-material laminate solutions together with Brückner.

BO-LLDPE

In collaboration with several resin suppliers and film converters Brückner has tested and evaluated the biaxial stretchability of a wide range of LLDPE resins. Interestingly the process windows depend – beyond others - significantly on resin parameters like the side chain type, the amount of side chains, the molecular weight and the molecular weight distribution. In a first screening test sequence the principal process parameters of different LLDPE types have been evaluated on a Karo V stretching machine in Brückner's technology center. Exemplarily Picture 2shows a comparison of material-specific processing windows for eight different LLDPE types.



Picture 2: Processing windows of different types of LLDPE types.

Subsequently, the stretching process of the most promising LLDPE grades had been scaled up to a continuous biaxial stretching process on Brückner's pilot line (also located in the technology center in Siegsdorf). In this way the process settings could be verified and refined before the next step had been taken: the production of sample rolls on existing BOPP production lines of Brückner customers. LLDPE-based BOPE film has been produced on BOPP lines in a commercial scale and the films have been provided to film converters for commercial field tests.

In packaging laminates a BOPE film made of LLDPE may be primarily used as a sealing layer. In comparison to BOPE films of course PP or PE cast sheets show superior sealing behavior and a low

thermal shrinkage. On the other hand, BOPE films offer advantages in terms of mechanical properties and a preferred opening behavior (directional tear). Compared to PE blown films BOPE films also have higher stiffness and superior optical properties. Also in terms of productivity PE blown films cannot compete with BOPE films from the biaxial tenter process.

Conclusion

The packaging industry has high expectations on laminate films made of polyethylene. Resin producers, film producers and film converters have carried out extensive R&D together with Brückner to optimize the resin properties and the resulting film properties. Brückner has introduced their latest hybrid line concepts for the production of BOPE or BOPP. The forthcoming optimization of the stretching process for HDPE materials for full-PE laminates will be the next big step of Brückner's contribution towards a true circular economy.

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