Sequential BOPP-HSS (High Seal Strength) films for optimized and cost-effective packaging applications

Simplification of multi-web structures is a trend in the food packaging industry. First target would be the use of duplex lamination structures instead of triplex designs without impairing protection functionalities of a food packaging, like barrier and sealing properties. Second target would be a cost reduction by down gauging due to the use of biaxially oriented films instead of blown films.

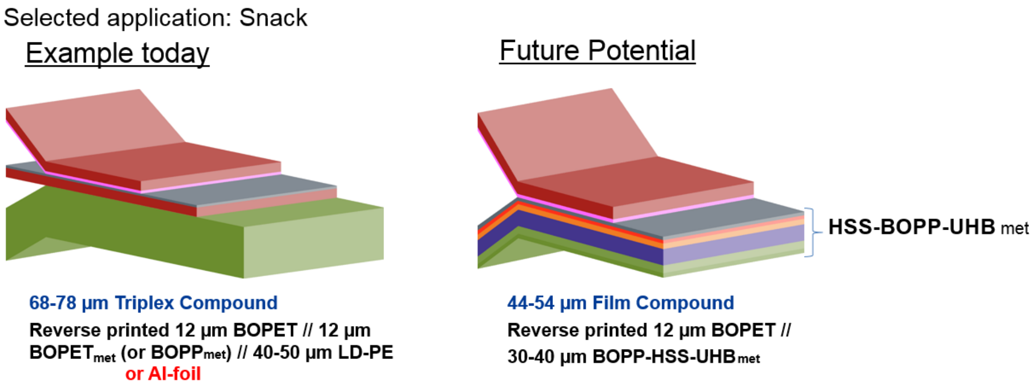

Figure 1: Packaging structure simplification potential for snack foods

Besides these cost savings, there are additional aspects like convenience, sustainability or recyclability, leading to a demand for monoweb/monomaterial solutions. This article highlights recent developments to achieve BOPP-HSS films under said targets.

BOPP HSS base films

By testing different sealing materials in a 5-layer BOPP structure, we achieved BOPP-HSS films with seal strength values exceeding 15 N/ 15 mm. The best heat seal results with PE-based sealing layers are shown in figure 2, "before lamination", 1348. Due to the specific formulations the mechanical properties of BOPP-HSS films are lower than for standard BOPP, optics acceptable.

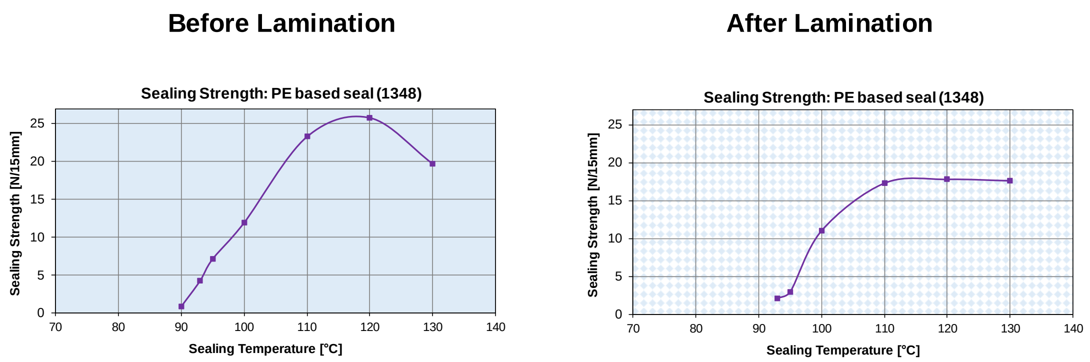

Figure 2: Seal strength curves of BOPP-HSS variable 1348 with PE-based sealing layers, before and after lamination against 12 µm BOPET

Lamination of BOPP-HSS base films against 12 µm BOPET webs

It is not possible to predict the behaviour of sealing films in the final packaging application by only using laboratory quality control measurements on the base films. Therefore the processability and final bag hermeticity was investigated on a laboratory VFFS packaging line with duplex-laminated structures, 30 µm HSS-BOPP//12 µm BOPET. We retested the sealing strength of the laminated structures, figure 2 presents these data for the PE-based HSS-film 1348, “after lamination”. It is essential to investigate the exact failure mechanism to be able to optimize the sealing structures regarding seal strength, adhesion, compatibility, lamination process as well as the performance on packaging lines.

VFFS packaging trials with fin seals

We used a BOSCH VFFS machine, bag height was 240 mm, width 150 mm, packaging speed 60 bags/minute. The transverse sealing seams were generated by serrated tools (crimp seals), crimp seal pressure was 2.5 kN, the longitudinal seam was performed as fin seal at constant temperature (185°C). For sealing tests with contaminated sealing areas a reproducible amount of flour has been added during the transverse (crimp) sealing process.

We evaluated air hermeticity and hot tack over a certain temperature and dwell time range. Air hermeticity has been investigated in a Pack-Vak leak detector, pillow bags withstanding a pressure of -0.3 bar have been considered as hermetically sealed against air:

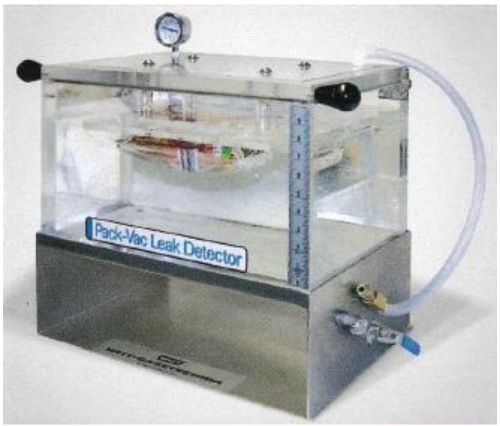

Figure 3: Pack-Vac leak detection unit

During hot tack testing plastic granulates have been used as filling good simulants (0.5 kg).

Selected Results

For the following discussion we selected two samples of laminated BOPET/BOPP-HSS structures, one with a PP copo-based, the other with a PE-based sealing layer, their sealing curves shown in figure 4. Considering these data only minor differences would be expected for the sealing performance of bags generated by these materials. The sealing strength as well as the SIT-level of sample 1026 seem to be slightly superior to that of 1218.

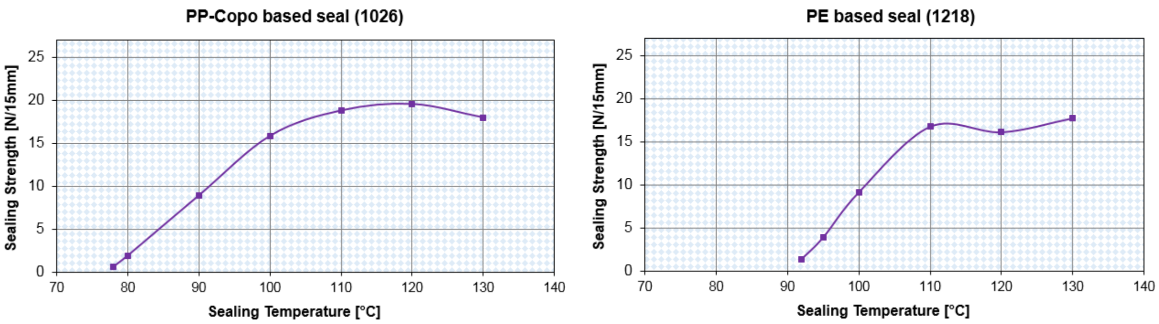

Figure 4: Seal strength curves of BOPP-HSS/BOPET laminates 1026 (PP copo-based seal) and 1218 (PE-based seal)

But the air hermeticity tests on flow bags produced on the BOSCH VFFS packaging line showed a different picture. With formulation 1026 (PP copo-based sealing layers) we achieved hermetically closed bags only at one temperature, 140°C, dwell time ≥400 ms. For the variable 1218 with PE-based sealing layers hermeticity was achieved over a broad temperature range between 120 and 140°C. For the 1218 variable at 140°C, dwell time 500 ms, the bags withstood even a pressure of -0.5 bar. The behaviour of 1218 against contamination was superior to that of 1026, too. The bag hot-tack behaviour of both variables was comparable.

These results make it obvious, that

- Laboratory quality control on base BOPP-HSS-film samples alone is not sufficient, trials on the intended packaging machines are essential
- PE-based sealing layers seem to be advantageous regarding hermeticity of final bag applications
- BOPP-HSS sealing films seem to be suited only for selected filling goods, mainly solid snack foods
- Sealing range is limited in comparison to thick laminated PE sealing layers
- Low SIT values for this kind of pillow pouch applications are not helpful, R&D aspects will have to be defined differently for the future
- Higher sealing temperatures could be required due to the higher stiffness of biaxially oriented films (bending at edges, bubbles).
- Processability of the BOPET/BOPP-HSS-films was very good, due to their higher stiffness and COF performance was fine
- Layout of the sealing jaws needs to be adapted in order to obtain the min. low pressure

Outlook: BOPP-HSS-HB or BOPP-HSS-UHB films

The next step will be the combination of a HSS-BOPP base film with the ultra-high barrier technology, providing mono-web films with excellent sealing properties as well as gas barrier values close to aluminium foil for duplex-lamination against e. g. 12 µm BOPET. Later on it would be necessary to develop a PP-based thermo-resistant layer (instead of the 12 µm BOPET film) to achieve a true monoweb/monomaterial solution. Applications could be “4 sealed-seams” bags and other flow bag packaging formats. Also for tray applications a PP/PE-based monoweb could be an interesting approach.

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