SPECIFIC
Starch – Poly Ethylene Compounds In Films with Improved barrier Characteristics

Annet Vrieling, Piet Buwalda (Avebe), Hans Martens, Maria Soliman (Sabic), Fresia Alvarado Chacón, Gerald Schennink, Herman de Beukelaer, Brigit Beelen, Maxence Paillart (WFBR)

Background

Polyethylene is known for its excellent waterproof properties, but also for its high oxygen permeability. On the other hand, starch is a good oxygen barrier, but it is water sensitive as well. A good mixture of both materials should result in products with high water- and oxygen-barrier properties. The combination of both materials in a blend is currently not used for the production of films, but it is potentially very interesting.

Polyethylene
PE
+
Thermoplastic starch
TPS

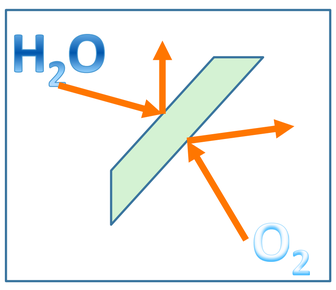

Figure 1. Water vapour and oxygen barrier

Objective

In the SPECIFIC project (September 2015-December 2017) rheology and structure of the TPS-PE blend were studied in order to improve film properties.

Generate background knowledge
for blends of
TPS - PE

- Factors to change **rheology** parameters (both in shear and in extension)?
- How to reduce **moisture** sensitivity?
- How to create more **adhesion** between the different components of a film?

Results

PE + TPS → extruder → **blend in pellets** → film blowing → **film properties**

System parameters

PE type
Ratio PE/TPS
plasticizer content
Melting temperature
Temperature profile
Mass flow rate
Starch type
plasticizer type
Screw type
Specific energy
Additives
Water content

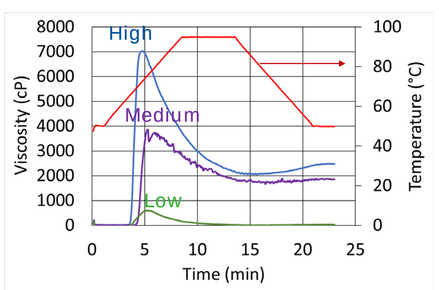

Figure 2. Viscosities of 3 different Avebe starch materials at 3 levels as measured by the rapid visco analyser (RVA)

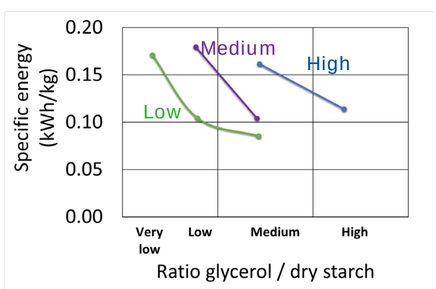

Figure 3. Specific energy at the extruder during blending 3 different types of starch with PE and different amounts of glycerol

Structure in pellets

When blending two different polymers at different ratios, the structure of the expected dispersed/ continuous phase can already be studied in the pellets. In our system the dispersed phase is the PE that will be further stretched during film blowing.

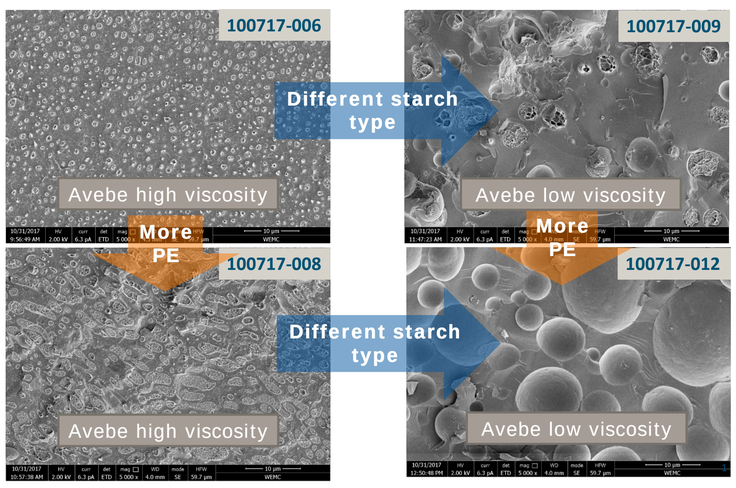

Figure 4. Cryo-SEM photographs of 4 different blends with two different types of Avebe starch and two different ratios of PE/TPS. The ratio glycerol/dry starch was kept constant.

Oxygen barrier

Figure 5. Film blowing trials at WFBR

Oxygen transmission rates (ml O_2/m².day.bar) corrected at 100µm are measured on the final blown film. Low values indicate the best barrier properties.

Avebe High	
23°C, 0 %RH	23°C, 70 %RH
7.6	1080
More PE	
Avebe High	
23°C, 0 %RH	23°C, 70 %RH
382	1385

Avebe Low	
23°C, 0 %RH	23°C, 70 %RH
4.35	1278
More PE	
Avebe Low	
23°C, 0 %RH	23°C, 70 %RH
9.65	1358

Conclusions and outlook

- Changes in rheology of initial materials such as starch type can largely influence the structure of the blend resulting in different film properties!
- The specific energy used by the extruder can be influenced by changing the amount of glycerol or by changing the starch type.
- RVA results on starch reflect on the blend extrusion settings!
- Characterizing the rheology of TPS-PE systems is challenging. During the project, methods to analyse the rheology of TPS were developed.
- Many other system parameters should still be studied to further improve the film properties such as moisture sensitivity and layer adhesion.

Acknowledgements

This work is part of the research programme Biobased Performance Materials, which is (partly) financed by the Top Sector Chemistry.

biobased performance materials

Project coordinator: Fresia Alvarado Chacón
Wageningen Food & Biobased Research
P.O. Box 17, 6700 AA Wageningen
Contact: fresia.alvaradochacon@wur.nl
T + 31 317 480734