Processing Guide
Extrusion paperboard coating with PLA

Revision date 07 May 2019
Page 1 of 4
Date previous version 12 Nov 2018
Version & language 1 - EN

Interested in solutions for bioplastics? Please contact us at
www.total-corbion.com **pla@total-corbion.com**

INTRODUCTION

This processing guide describes the process of extrusion paperboard coating with PLA. Extrusion coating is a process enabling the production of multilayered structures. The process consists of the extrusion of a thermoplastic material onto a substrate such as paper, paperboard, etc. Typical applications are milk and juice cartons, hot paper drinking cups, frozen food and dairy containers, plastic lined paper bags and take-out containers.

Conventionally, Low Density Polyethylene (LDPE), a branched polyolefin, is used for paper and paperboard coating due to its resistance to water and grease. There are two main advantages for PLA coated paperboard. Firstly, It does not require an additional recycling step to separate the PE from the paper before the paper is submitted for industrial composting. Secondly, when recycling the paper, PLA does not interfere with the paper recycling process.

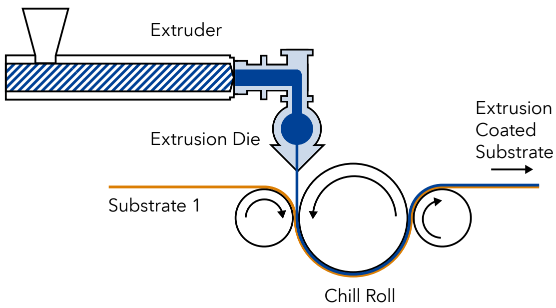

Figure 1: Basic setup of an extrusion coating process.

Poly Lactic Acid (PLA) is a biobased thermoplastic polymer derived from annually renewable resources. It is certified industrially compostable according to EN 13432 and ASTM D6400. It can be processed via conventional extrusion coating technologies to obtain coated product that can meet the industrial compostable requirements. It is the responsibility of the final product manufacturer to obtain final product certification.

PLA is a linear aliphatic polyester, characterized by a low melt strength, high neck-in and low elongational viscosity, which can negatively affect the processing and product properties. To eliminate these shortcomings, the use of certain additives is highly recommended. Melt strength enhancers and/or branching additives can be used to reduce the neck-in, improve the processing speed and reduce the coating weight. The obtained flow characteristics are similar to PE. At high elongational rates the modified PLA also shows strain hardening which makes it possible to obtain thinner coatings than when using neat PLA resins in coating lines.

STORAGE CONDITIONS

It is recommended to store PLA polymers and compounds in its closed, original moisture-barrier packaging at temperatures below 50°C. Storage in direct sunlight should be avoided. The supplied PLA pellets are typically semi-crystalline.

PLA RESIN PROPERTIES

PLA grade recommended for paper board coating lines.

PLA neat resin	Glass transition temperature (T_g)	Melting temperature (T_m)	MFI (Flow, 210°C / 2.16 kg)
Luminy® LX175	60	155	6

Table 1: PLA grade for paper board coating lines.

TOTAL Corbion

TCP-PG-EXTPBCOAT-V1-EN-190507

ADDITIVES

In Table 2, a number of typical additives are listed that can be used in extrusion coating of PLA to modify the flow and coating behavior.

Additive	Functionality	Recommended loading	Food Contact Approval EU*	Food Contact Approval USA*
Joncryl ADR 4400	Decrease neck-in Edge stability Increase process speed	0.25 - 0.4%	Yes	Yes (max. 0.4% w/w)
Vinnex 2525	Process speed Edge stability	7-8%	Yes	Yes
Ecoflex C1200	Decrease neck-in Reduces yellowness	5-20%	Yes	Yes
** Based on information provided by the suppliers. Specific migration levels and restrictions on the conditions of use or food types could apply, for more information please contact the suppliers directly. It is the responsibility of the manufacturer of the final product, when intended as a food contact product, to determine that the use of the product is safe and also suitable for the intended application.*				

Table 2: Example additives for extrusion coating of PLA.

DRYING PLA

Luminy® PLA resins are supplied in sealed aluminum-lined moisture-barrier packaging with a maximum moisture content of 400 ppm. It is recommended to reduce the moisture content before melt processing to a level less than 250 ppm and preferably to 100 ppm. Moisture causes hydrolysis of the PLA homopolymer during melt processing, resulting in reduced processing stability and also mechanical performance in the final part.

Luminy® PLA resins can be dried using most conventional drying systems. The preferred method to dry PLA is by using a desiccant hot air dryer system. Another option is to use a vacuum drying oven. It is highly recommended to check the actual moisture content after drying, for which the Karl-Fischer or Brabender Aquatrac methods can be used. In case additives are used, it is also recommended to check the moisture content of the additives and dry them if necessary.

The dried PLA should be processed as soon as possible after drying and preferably under an inert (Nitrogen) atmosphere to prevent moisture uptake. Starting at 100ppm moisture content, the critical level of 250ppm is already reached after 15 minutes of exposure to atmospheric conditions (Figure 2).

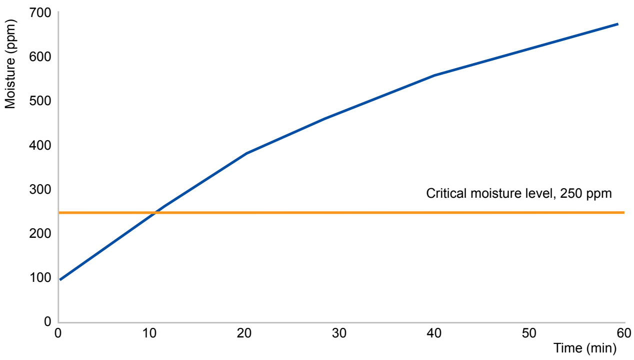

Figure 2: Moisture take-up curve PLA homopolymer

The packaging should be kept sealed before usage and any unused material should be resealed immediately. It is recommended to have a closed system from the dryer into the feeder, a dryer installed on top of the feeder, or to apply a dry nitrogen blanket in the feeder and throat of the extruder to prevent moisture uptake. Typical PLA drying conditions using a desiccant hot air dryer are shown in table 3.

Parameter	Pre-crystallized standard PLA (Luminy® LX175)
Drying time	4-6 hours
Air temperature	85°C
Air dew point	< -40°C

Table 3: Typical PLA drying conditions

START-UP AND SHUTDOWN

Before introducing Luminy® PLA, the extrusion equipment needs to be well cleaned and purged to prevent cross contamination. Also, make sure that the feeding and blending equipment in the material preparation steps (before the materials and additives enter the extruder) is extensively cleaned and that they are free of dust and contamination. The purging procedures below are recommended for removing other polymers when processing PLA.

1. Check if other polymers from previous runs are present in the barrel of the machine. To prevent starting up the machine with non-molten material, the temperature range of the machine should be set to the processing temperature of the previously used polymer or the PLA, whichever has the highest processing temperature.
2. Purge the system with a polyolefin with similar MFI to PLA, or a purging compound (e.g. ASAclean, Dyna-Purge, etc.) followed by purging with the PLA.
3. Change the temperature of the barrel to the required temperature for PLA.
4. Check that the processed material is free of contamination before starting production.
5. At completion of the run, it is recommended to purge the system again by using a purging compound to clean the machine from remaining PLA material for 5 times the average residence time. Check the recommendations of the supplier of the purging material for the right conditions.

After completion of the run, PLA must be removed from the whole system. PLA can degrade over time into lactic acid causing corrosion of the equipment.

EXTRUSION

Paperboard coating of PLA can be done on conventional processing equipment. The recommended processing temperatures are shown in Table 4:

Parameter	Unit	Setting
Feed zone	°C	160-180
Cooled feeding zone	°C	20-40
Compression zone	°C	200-240
Metering zone	°C	210-270
Die	°C	210-270
Chill roll	°C	30-40

Table 4: Recommended processing temperatures for paperboard extrusion coating.

Please keep in mind the following when performing paperboard coating of PLA:

- In order to minimize the neck-in as much as possible, the air-gap should be kept to the minimum.
- The use of a corona treatment – as is typically performed on PE – is not necessary on PLA. However, it is recommended to use a corona treatment on the (paper, paper board) substrate to increase adhesion.

Processing Guide
Extrusion paperboard coating with PLA

- Single or multi-layer structures are possible to tune coatability and performance.
- In order to avoid bridging in the feeding zone, it is necessary to use a cooling system in the extruder, placed just below the hopper, mainly for amorphous or non-crystallized grades.

DISCLAIMER

No representation or warranty is made as to the truth or accuracy of any data, information or opinions contained herein or as to their suitability for any purpose, condition or application. None of the data, information or opinions herein may be relied upon for any purpose or reason. Total Corbion PLA disclaims any liability, damages, losses or other consequences suffered or incurred in connection with the use of the data, information or opinions contained herein. In addition, nothing contained herein shall be construed as a recommendation to use any products in conflict with existing patents covering any material or its use.