

PROCESSING GUIDANCE

Extrusion of PLA Sheet&Film



•Introduction

This is a processing guidance of PLA sheet&film extrusion. Hisun has developed different kinds of extrusion-use PLA grades which meet the requirements of transparency, heat resistance, toughness, etc. Typical applications include thermoforming products, laminated/coating products, biaxial oriented stretched films(hereinafter referred to as BOfilm), etc. These PLA grades can be processed by conventional extrusion machines.

Extrusion is a general processing technology. The process parameters provided in this processing guidance are only for your reference. It is suggested that the above parameters should be adjusted according to your own equipment and processing conditions in order to find the best process conditions suitable for you.

•Typical Physical Properties

Physical Properties	Unit	Test Standard	Pure PLA			PLA Compounds	
			REVODE 101 Sheets Laminate BOfilm	REVODE 110 Sheets Laminate BOfilm	REVODE 190 Sheets Fiber BOfilm	REVODE 161 Sheets	REVODE 171 Sheets
Density	g/cm ³	GB/T1033.1-2008	1.20-1.30	1.20-1.30	1.20-1.30	1.25-1.35	1.35-1.45
Melt Index (190°C/2.16Kg)	g/10min	GB/T3682.1-2018	2-12	2-12	2-12	≤6	≤6
Melting Point	°C	GB/T19466.3-2004	<155	155-170	170-180	155-175	155-175
Glass Transition Temperature	°C	GB/T19466.2-2004	56-60	56-60	56-60	54~60	54~60
Tensile Strength	MPa	GB/T1040.1-2018	≥50	≥50	≥50	≥40	≥40
Elongation at Break	%	GB/T1040.1-2018	≥3	≥3	≥3	≥200	≥100
Notched Impact Strength	kJ/m ²	GB/T1043.1-2008	≥1	≥1	≥1	≥1	≥1

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•Storage condition

PLA resin has been dried before leaving our factory and is sealed with vacuum aluminum-plastic composite bags. Because PLA is easy to absorb water, being exposed to air for a long time will lead to the increase of resin's flow rate and brittleness of final products during processing. Please use it as soon as possible after opening the package, and seal it quickly if not finished. PLA should be stored in a ventilated, dry warehouse instead of open air which is away from the source of fire and direct sunlight. The ambient temperature should not exceed 40 °C during storage.

•Drying

REVODE PLA has been dried before leaving the factory and sealed with vacuum aluminum-plastic composite bags to keep its moisture content less than 500ppm. Laminate/coating processing has strict requirements on moisture, so it is recommended to dry the moisture below 100ppm before processing. Because PLA is easy to absorb water, being exposed to air for a long time will lead to the increase of resin's flow rate and brittleness of final products during processing. Please use it as soon as possible after opening the package, and seal it quickly if not finished. For the drying conditions of resin after water absorption, please refer to the following table:

Drying Parameter	Unit	REVODE	REVODE	REVODE	REVODE	REVODE
		101	110	190	161	171
Residence Time	h	3-4	2-3	2-3	2-3	2-3
Air Temperature	°C	60	70	90	70	70
Air Dew Point	°C	-40	-40	-40	-40	-40
Air Flow Rate	m ³ /hr-kg resin	>1.85	>1.85	>1.85	>1.85	>1.85

•Requirements on the Equipment

• Sheets Extrusion

PLA sheet was processed by single-screw extruder with L/D ratio from 24:1 to 36:1. In order to ensure the melt quality and improve the production efficiency, it is recommended that mixersmelt pump or static should be

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installed prior to the die to ensure the stability of material conveying. It is recommended to use the hanger-type die, and the die gap should be set to be about 50% larger than the sheet size.

Sheet forming should be done on 3-roll stack, which requires an accurate temperature control system. 3-roll stack temperature profiles vary depending on the output, melt temperature and roll diameters. The rolls can be divided into three parts(Top roll, Middle roll, Bottom roll) according to the distance from the die. Recommended original temperature settings are listed as follows:

Roll	Temperature Setting
Top roll	40°C
Middle roll	35°C
Middle roll	25°C

Note: 1. The above temperature can be adjusted according to the equipment and production conditions.

2. If the roll temperature is too low, a small number of monomers may precipitate in top and middle roll, and sheet sticking may occur if the temperature is too high.

During thermoforming, please set the suitable baking temperature and time according to the actual situation of the equipment. While using Revode721 to make heat-resistant product, please heat the mold by heat conducting oil or electricity. It is recommended to control the temperature at 90-110°C.

• Laminating/ Coating

PLA can be processed on conventional PE coating machine. It is recommended to set the L/D ratio from 24:1 to 36:1. In order to make the processing more stable, you can equip the machine with melt pump. Laminate on the machine according to the normal process, and the linear velocity should be controlled within 50-100m/min according to different machine models. The paper is treated with corona before coating to increase the surface roughness, thus the paper-plastic composite strength can be increased. After the edge of the laminated paper is cut and the paper is rolled into roll. Adjust the gap between the die lips and the temperature of the die to make the weight of the film uniform. The shrinkage of PLA film from die head is larger than that of PE film. Reducing the distance between die and cooling roller as well as the gap between die lips on both sides of die can effectively solve the problem of thick on sides but thin in middle caused by excessive shrinkage. After the processing of PLA laminating, if you need to process PE, it is recommended to raise the temperature to 280°C and directly use PE

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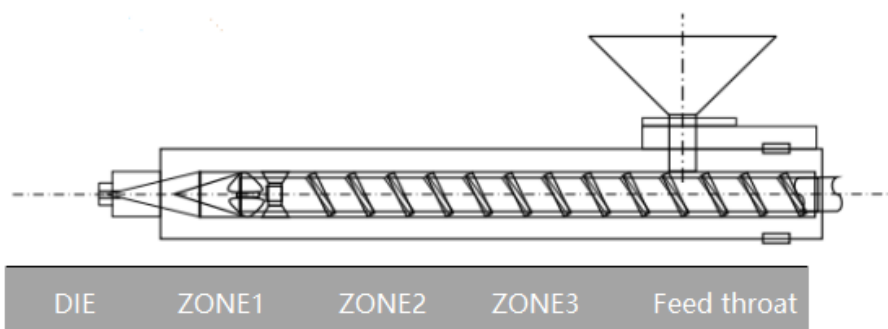


material for transition processing. If it is a special machine for PLA, the temperature can be reduced to about 150°C before finishing laminating.

When stopping for a short time (usually within half an hour) during processing, close the baffle at the bottom of the hopper and empty the leftover material in the barrel. When restarting production, open the baffle to add material. If the material yellowing, degradation and other phenomena occur during processing, the material in the barrel should be emptied first, and the state of the material should be observed to see if it returns to normal after the replacement of the new material. If it is not normal, you need to observe whether water absorption, high processing temperature or other problem occurred, or you can also contact us to solve it.

•Processing Temperature

	Unit	REVO 101	REVO 110	REVO 190	REVO 161	REVO 171
Die	°C	170-190	180-200	180-200	180-200	180-200
Melt Pump	°C	170-190	180-200	180-210	180-210	180-210
Filter	°C	170-200	180-200	180-210	180-210	180-210
Zone 3	°C	170-200	180-200	180-210	180-210	180-210
Zone 2	°C	170-200	180-200	180-210	180-210	180-210
Zone 1	°C	170-180	160-180	180-210	180-200	180-200
Feed Throat	°C	20-40	20-40	20-40	20-40	20-40



Notice: 1.The above temperature can be adjusted according to the equipment and production conditions.

2.In case of laminating/coating, the temperature of the other section except the feeding throat should be increased by 20-30 °C.

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•Coloring

It is recommended to use special toner or PLA-based color masterbatch, improper toner and color masterbatch may make the final products brittle, unsmooth and even unable to be extruded, etc. If the raw materials for coloring can not be processed within 2 hours after opening, please seal it.