NatureWorks® PLA Polymer 2100D

Extrusion/Thermoforming

NatureWorks® PLA polymer 2100D, a NatureWorks LLC product, is a thermoplastic resin intended for higher heat applications. Derived primarily from annually renewable resources, it is specifically designed for extrusion/thermoforming applications. PLA polymer 2100D is an opaque extrusion sheet grade and processes easily on conventional extrusion and thermoforming equipment. See table at right for properties.

Typical Material & Application Properties [1]		
Physical Properties	**PLA Polymer 2100D**	**ASTM Method**
Specific Gravity	1.30	D792
Melt Index, g/10 min (190ºC/2.16K)	5-15	D1238
Clarity	Opaque	
Mechanical Properties		
Tensile Strength @ Break, psi (MPa)	8,100 (56)	D638
Tensile Yield Strength, psi (MPa)	9,000 (62)	D638
Tensile Modulus, kpsi (GPa)	500 (3.5)	D638
Tensile Elongation, %	3.0	D638
Notched Izod Impact, ft-lb/in (J/m)	0.37 (19.8)	D638

[1] Typical properties; not to be construed as specifications.

Applications

Potential applications for PLA polymer 2100D include:

- Plates and Bowls for hot food serviceware
- Shallow Draw Microwavable Trays

Processing Information

PLA polymer 2100D is easily processed on conventional extrusion equipment. The material is stable in the molten state, provided that the drying procedures are followed.

Machine Configuration

PLA polymer 2100D will process on conventional extrusion machinery with the following equipment: General purpose screw with L/D ratios from 24:1 to 30:1 and compression ratio of 2.5:1 to 3:1. Smooth barrels are recommended.

Process Details

Startup and Shutdown

PLA polymer 2100D is not compatible with a wide variety of polyolefin resins, and special purging sequences should be followed:

1. Clean extruder and bring temperatures to steady state with low-viscosity, general-purpose polystyrene or polypropylene.
2. Vacuum out hopper system to avoid contamination.
3. Introduce PLA polymer into the extruder at the operating conditions used in Step 1.
4. Once PLA polymer has purged, reduce barrel temperatures to desired set points.
5. At shutdown, purge machine with high-viscosity polystyrene or polypropylene.

Drying

In-line drying may be required. A moisture content of less than 0.025% (250 ppm) is recommended to prevent viscosity degradation. Typical drying conditions for crystallized granules are 4 hours at 158ºF (70ºC) or to a dew point of -30ºF (-34ºC), airflow rate of greater than 0.5 cfm/lbs per hour of resin throughput. The resin should not exposed to atmospheric conditions after drying. Keep the package sealed until ready to use and promptly reseal any unused material.

Processing Temperature Profile [1]		
Melt Temperature	410ºF	210ºC
Feed Throat	113ºF	45ºC
Feed Temperature	355ºF	180ºC
Compression Section	375ºF	190ºC
Metering Section	390ºF	200ºC
Adapter	390ºF	200ºC
Die	390ºF	200ºC
Screw Speed	20-100 rpm	

[1] NatureWorks® PLA Sheet Extrusion Processing Guide is available at www.natureworksllc.com

Use of Regrind

Amorphous regrind may be introduced into the feed stream at levels up to 50% without an adverse effect on extruder performance. At levels above 50%, crystallization of the regrind is recommended to prevent screw sticking.

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Compostability

Composting is a method of waste disposal that allows organic materials to be recycled into a product that can be used as a valuable soil amendment. PLA is made primarily of polylactic acid, a repeating chain of lactic acid, which undergoes a 2-step degradation process. First, the moisture and heat in the compost pile attack the PLA polymer chains and split them apart, creating smaller polymers, and finally, lactic acid. Microorganisms in compost and soil consume the smaller polymer fragments and lactic acid as nutrients. Since lactic acid is widely found in nature, a large number of organisms metabolize lactic acid. At a minimum, fungi and bacteria are involved in PLA degradation. The end result of the process is carbon dioxide, water and also humus, a soil nutrient. This degradation process is temperature and humidity dependent. Regulatory guidelines and standards for composting revolve around four basic criteria: Material Characteristics, Biodegradation, Disintegration, and Ecotoxicity. Description of the requirements of these testing can be found in the appropriate geographical area: DIN V 54900-1 (Germany), EN 13432 (EU), ASTM D 6400 (USA), GreenPla (Japan). This grade of NatureWorks® PLA meets the requirements of these four standards with limitation of maximum layer thickness of 1650 µm and for coating layers up to 37 µm thick.

FDA Status

U.S. Status-

This is to advise you that on January 3, 2002 FCN 000178 submitted by NatureWorks LLC to FDA became effective. This effective notification is part of list currently maintained on FDA's website at http://www.cfsan.fda.gov/~dms/opa-fcn.html. This grade of NatureWorks® PLA may therefore be used in food packaging materials and, as such, is a permitted component of such materials pursuant to section 201(s) of the Federal, Drug, and Cosmetic Act, and Parts 182, 184, and 186 of the Food Additive Regulations. All additives and adjuncts contained in the referenced NatureWorks® PLA formulation meet the applicable sections of the Federal Food, Drug, and Cosmetic Act. The finished polymer is approved for all food types and B-H use conditions. We urge all of our customers to perform GMP (Good Manufacturing Procedures) when constructing a package so that it is suitable for the end use. Again, for any application, should you need further clarification, please do not hesitate to contact NatureWorks LLC.

European Status-

This grade of NatureWorks® PLA complies with EU Plastics Directive 2002/72/EC, which applies to all EU member states. The Plastics Directive is a consolidated version of the "Monomers Directive (Commission Directive 90/128/EEC) and its first 7 amendments. This grade of NatureWorks® PLA is also in compliance with "Bedarfgegenstände Gesetz", which is the German implementation of the EU Plastics Directive 2002/72/EC. Substances used in the manufacturing of this product which are not yet regulated by EU Plastics Directive 2002/72/EC, as amended, are in compliance with appropriate EU national regulations. NatureWorks LLC would like to draw your attention to the fact that the EU-Directive 2002/72/EC, which applies to all EU-Member States, includes a limit of 10 mg/dm2 of the overall migration from finished plastic articles into food. In accordance with EU-Directive 2002/72/EC the migration should be measured on finished articles placed into contact with the foodstuff or appropriate food simulants for a period and at a temperature which are chosen by reference to the contact conditions in actual use, according to the rules laid down in EU-Directives 93/8/EEC (amending 82/711/EEC) and 85/572/EEC Please note that it is the responsibility of both the manufacturers of finished food contact articles as well as the industrial food packers to make sure that these articles in their actual use are in compliance with the imposed specific and overall migration requirements. Again, for any application, should you need further clarification, please do not hesitate to contact NatureWorks LLC.

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Safety and Handling Considerations
Material Safety Data (MSD) sheets for PLA polymers are available from NatureWorks LLC. MSD sheets are provided to help customers satisfy their own handling, safety, and disposal needs, and those that may be required by locally applicable health and safety regulations, such as OSHA (U.S.A.), MAK (Germany), or WHMIS (Canada). MSD sheets are updated regularly; therefore, please request and review the most current MSD sheets before handling or using any product. The following comments apply only to PLA polymers; additives and processing aids used in fabrication and other materials used in finishing steps have their own safe-use profile and must be investigated separately.

Hazards and Handling Precautions
PLA polymers have a very low degree of toxicity and, under normal conditions of use, should pose no unusual problems from incidental ingestion, or eye and skin contact. However, caution is advised when handling, storing, using, or disposing of these resins, and good housekeeping and controlling of dusts are necessary for safe handling of product. Workers should be protected from the possibility of contact with molten resin during fabrication. Handling and fabrication of resins can result in the generation of vapors and dusts that may cause irritation to eyes and the upper respiratory tract. In dusty atmospheres, use an approved dust respirator. Pellets or beads may present a slipping hazard. Good general ventilation of the polymer processing area is recommended. At temperatures exceeding the polymer melt temperature (typically 170˚C), polymer can release fumes, which may contain fragments of the polymer, creating a potential to irritate eyes and mucous membranes. Good general ventilation should be sufficient for most conditions. Local exhaust ventilation is recommended for melt operations. Use safety glasses, if there is a potential for exposure to particles, which could cause mechanical injury to the eye. If vapor exposure causes eye discomfort, use a full-face respirator. No other precautions other than clean, body-covering clothing should be needed for handling PLA polymers. Use gloves with insulation for thermal protection when exposure to the melt is localized.

Combustibility
PLA polymers will burn. Clear to white smoke is produced when product burns. Toxic fumes are released under conditions of incomplete combustion. Do not permit dust to accumulate. Dust layers can be ignited by spontaneous combustion or other ignition sources. When suspended in air, dust can pose an explosion hazard. Firefighters should wear positive-pressure, self-contained breathing apparatuses and full protective equipment. Water or water fog is the preferred extinguishing medium. Foam, alcohol-resistant foam, carbon dioxide or dry chemicals may also be used. Soak thoroughly with water to cool and prevent re-ignition.

Disposal
DO NOT DUMP INTO ANY SEWERS, ON THE GROUND, OR INTO ANY BODY OF WATER. For unused or uncontaminated material, the preferred options include recycling into the process or sending to an industrial composting facility, if available; otherwise, send to an incinerator or other thermal destruction device. For used or contaminated material, the disposal options remain the same, although additional evaluation is required. (For example, in the U.S.A., see 40 CFR, Part 261, “Identification and Listing of Hazardous Waste.”) All disposal methods must be in compliance with Federal, State/Provincial, and local laws and regulations.

Environmental Concerns
Generally speaking, lost pellets are not a problem in the environment except under unusual circumstances when they enter the marine environment. They are benign in terms of their physical environmental impact, but if ingested by waterfowl or aquatic life, they may mechanically cause adverse effects. Spills should be minimized, and they should be cleaned up when they happen. Plastics should not be discarded into the ocean or any other body of water.

Product Stewardship
NatureWorks LLC has a fundamental duty to all those that make and use our products, and for the environment in which we live. This duty is the basis for our Product Stewardship philosophy, by which we assess the health and environmental information on our products and their intended use, then take appropriate steps to protect the environment and the health of our employees and the public.

Customer Notice
NatureWorks LLC encourages its customers and potential users of its products to review their applications for such products from the standpoint of human health and environmental quality. To help ensure our products are not used in ways for which they were not intended or tested, our personnel will assist customers in dealing with ecological and product safety considerations. Your sales representative can arrange the proper contacts. NatureWorks LLC literature, including Material Safety Data sheets, should be consulted prior to the use of the company’s products. These are available from your NatureWorks LLC representative.

For additional information in the U.S. and Canada,
call toll-free 1-877-423-7659
In Europe, call 31-(0)35-699-1344
In Japan, call 81-33-285-0824

15305 Minnetonka Blvd., Minnetonka, MN 55345