

**Sulzer PLA Technology**



# PLA Technology at Sulzer Chemtech

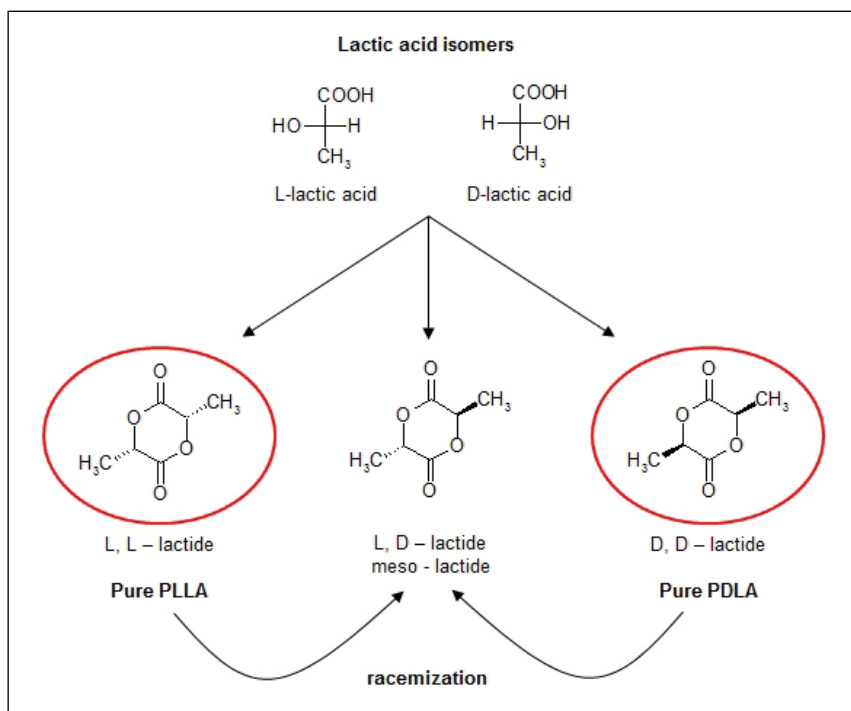
Sulzer Chemtech, a member of the Sulzer Corporation, with headquarters in Winterthur, Switzerland, is active in the field of process engineering, employing 3,500 persons worldwide. Sulzer Chemtech is represented in all important industrial countries setting standards in the field of mass transfer and static mixing with its advanced and economical solutions.

Sulzer Chemtech is organized into four business units, one of which is the Process Technology group. This business unit was formed in early 2009 following the acquisition of Kühni, a Swiss company with more than 75 years experience in innovative separation processes. Today, Sulzer Chemtech Process Technology is headquartered in Allschwil (Basel), Switzerland. We provide a unique and wide portfolio of separation and application technologies, amongst which polymer production technology for poly lactic acid (PLA).

## Sulzer PLA Technology

Bio-based polymers made from renewable feedstocks have started to replace conventional polymers produced from fossil fuel. We offer a complete plant solution for a PLA polymerization process which was jointly developed with Purac, a company of the Dutch CSM group. Lactide monomer is polymerized in a continuous, fully integrated process using Sulzer's proprietary SMR™ plus equipment. The unique geometry of the Sulzer Mixing Reactor is highly suited for an accurate control of the (exothermic) polymerization temperature and optimized mixing. Summarizing, our state-of-the-art PLA polymerization technology has the following advantages over other technologies:

- Highly efficient polymerization process using Sulzer's advanced static mixing and heat exchanger technology
- Capability to switch fast between different PLA grades due to short residence times and plug flow behavior
- Flexibility to produce different PLA grades with a wide range of molecular weights
- Ability to handle viscosity changes of 6 orders of magnitude (up to 5,000 Pa.s)
- Compact, customizable plant footprint
- Fully scalable to different plant capacities
- Competitive production costs
- Reduced maintenance costs due to static equipment



## The PLA Process

Our ring-opening polymerization process starts with melting solid L- and/or D-lactide monomer. The catalyst and the initiator are subsequently mixed with the monomer and heated up to the reaction temperature. We use the advantages of a two-stage continuous reaction system to control the ring-opening polymerization and reach conversion at thermodynamic equilibrium (95 %).

The residual monomer is continuously removed from the PLA melt in a two-stage, vacuum degassing system. The recovered unreacted lactide can be purified and recycled into the feed system. The degassed PLA is subsequently pelletized and crystallized before packaging.



Sulzer Mixing Reactor (SMR™)

## Product Specification

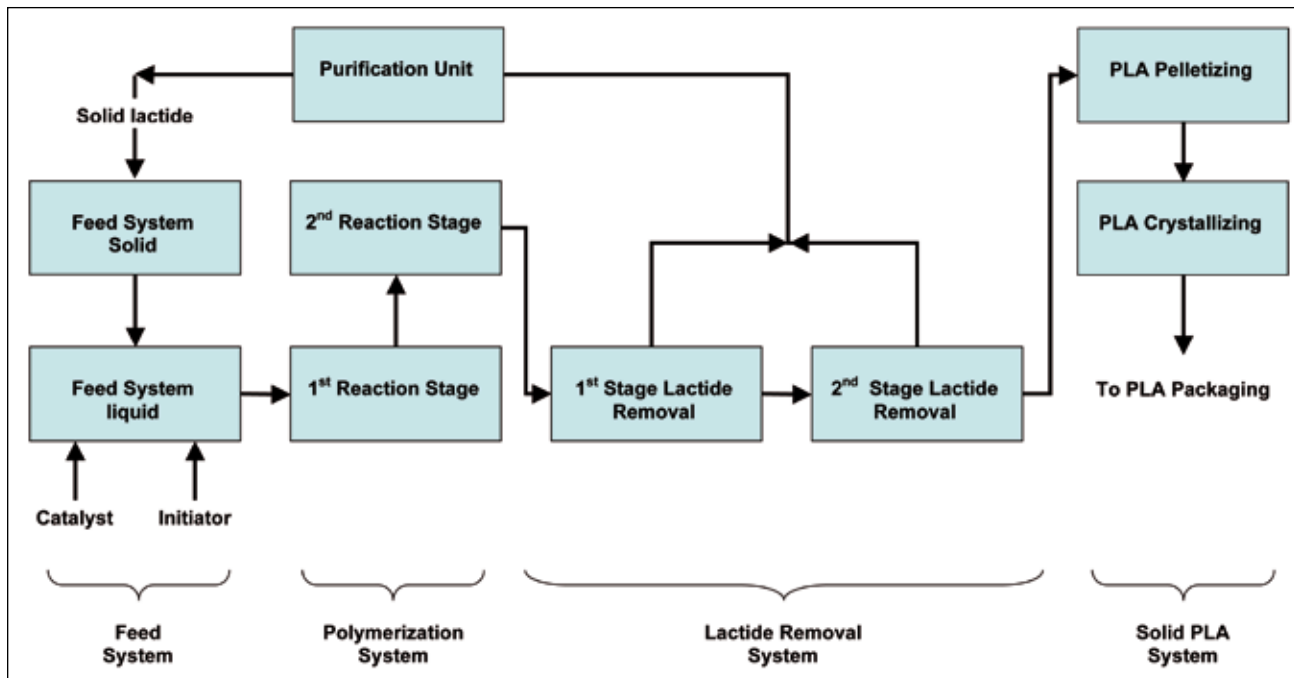
Our unique PLA process gives access to a wide range of PLA grades based on our established recipes, exhibiting a very low level of racemization and low yellowness index.

Sulzer PLA Product Specification	
$M_n$ (number average molecular weight)	50 - 150 kg/mol
Residual volatiles	< 0.3 %
Racemization	< 0.5 %
Stereochemical composition	100 % PLLA, 100 % PDLA, PDLLA with 1-10 % D content

# Sulzer PLA Technology

## Plant Solutions and Scope of Supply

We offer you a unique, proprietary technology for the production of performance bio-based PLA



### Sulzer PLA Production Units

Our offering includes a wide range of different plant capacities. Small capacities are delivered as a skid-based solution, whereas large capacities will be delivered as key equipment (partly pre-assembled) for on-site installation. Individual plant capacities and layouts can be engineered upon your request.

### Our Scope of Supply

We offer a complete technology package, including our proprietary key equipment, delivered with guaranteed performance. As our customer, we provide you first class engineering and commissioning support for the start-up of your plant. We support your in-house development with



Our skid-mounted PLA plant on its way from our workshop for installation at the production site

the production of demonstration samples from our own PLA demonstration plant.

PLA sample



Plant Model	Plant Capacity	Installation
SPLA1	1 kt/y	Skid-based
SPLA5	5 kt/y	Skid-based
SPLA10	10 kt/y	Skid-based
SPLA25	25 kt/y	Site-built
SPLA50	50 kt/y	Site-built
SPLA75	75 kt/y	Site-built
SPLA100	100 kt/y	Site-built



# Sulzer PLA Technology

## PLA Applications and Demonstration Samples

We supply bulk PLA samples for your own in-house testing from our demonstration plant in Switzerland

### Wide Range of Application

PLA materials produced with our technology are suitable for a wide range of applications, many of which have already been tested under industrial conditions:

- Fibers
- Extrusion
- Injection molding
- Thermoforming
- Blow-molding
- Foams
- Films

Due to its extremely low degree of racemization, the Sulzer PLA process gives access to almost pure PLLA and PDLA for stereo-complex production. So-called scPLA is a blend of PLLA and PDLA with outstanding mechanical performance in hot temperature applications up to 200 °C.

### Customer Sampling

Since 2012 we own and operate a complete 1,000 t/yr PLA production unit. This unit can produce customer-specific grades and enables us to provide you with large quantities of sample material for in-house evaluation, industrial testing and product development. Samples are available either in 20 kg bags or 600 kg octabins. For specialties and product samples in smaller quantities, we also offer customer testing in our own dedicated, state-of-the-art R&D facilities.



Sulzer PLA production plant at one of our customers

Plant Model	Lactide Melting	Reaction	Devolatilization	Lactide Recycling	Upgrading
SPLA1	x	x	x	x	x
SPLA5	x	x	x	x	x
SPLA10	x	x	x	x	x
SPLA25	x	x	x	x	x
SPLA50	-	x	x	x	x
SPLA75	-	x	x	x	x
SPLA100	-	x	x	x	x

\* For PLA units larger than 50 kt/y the PLA plant is usually directly connected to a lactide plant

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