Application Technologies (Polylactic acid)

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The construction of this study

boil＞＞＞keep the pressure

＞＞＞temperature, time

① Collect lactic acid from polylactic acid

② The decomposition of lactic acid, byproduct

Polylactic acid

Hydrothermal reaction

Lactic acid

Degradation product

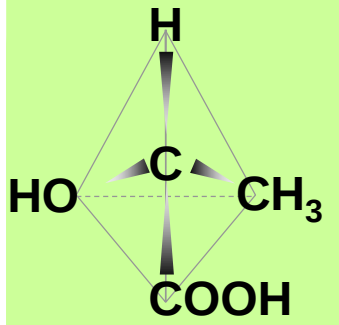
Improvement of physical properties

○Additive (flame retardant, fillers, etc.)

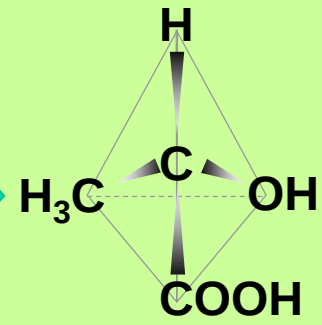
Kenaf, catalyst

Combination with other polymers

○Mixture (plastic derived from oil)



L−lactic acid

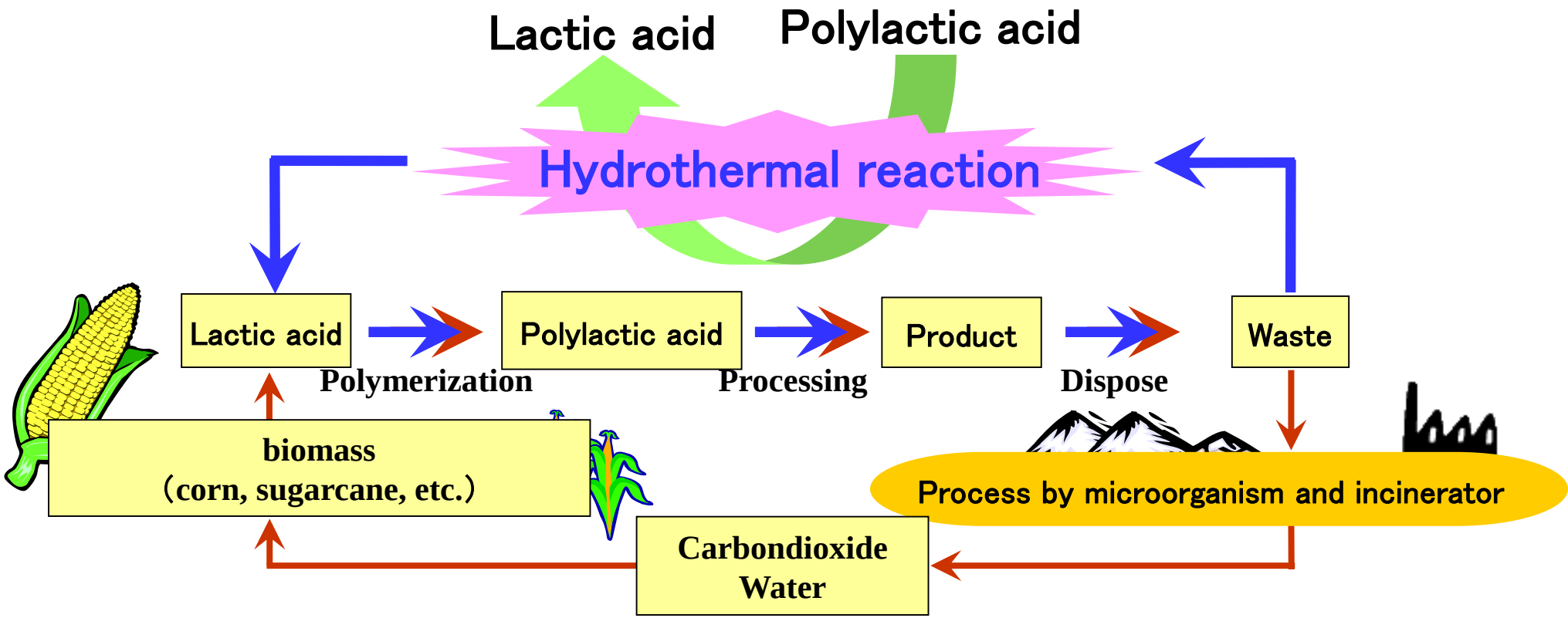


D−lactic acid

④ Effects of the mixture

③ Optical isomerization reaction

Development and promotion of the polylactic acid chemical recycle technology



●Current problem

- Competition with the food production because it is derived from plant
- Validity between biodegradation rate and carbon neutral
- Polylactic raw materials depend on imports
- Mass production, mass consumption, mass disposal

●Advantages of the chemical recycle

- Reduction of the competition problem with the food production
- Reduction of the discharge of CO_2
- Construction industry that is not depended on import
- Promotion of the cyclical use

Polylactic Acid Chemical Recycle Problem

biomass

Can this energy resource be supplied steadily and will not be depleted ?

Mitsui Chemicals, Inc.: General-purpose resin
Toyota: Kenaf clay

Extraction

starch

Lactic fermentation

lactic acid

Polymerization

Polylactic acid

- The problem of the optical purity?
- The influence of additive, mixture?
- The general evaluation?

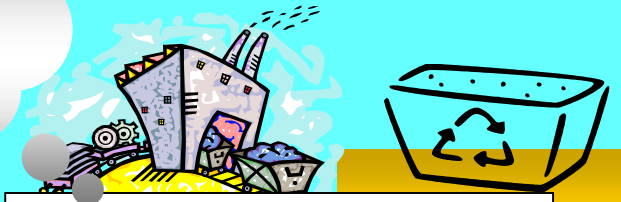
Chemical Recycle

Break down

Processing

Manufacture

CO_2



Incinerate, compost

Agriculture material and other things which has difficulty in collection

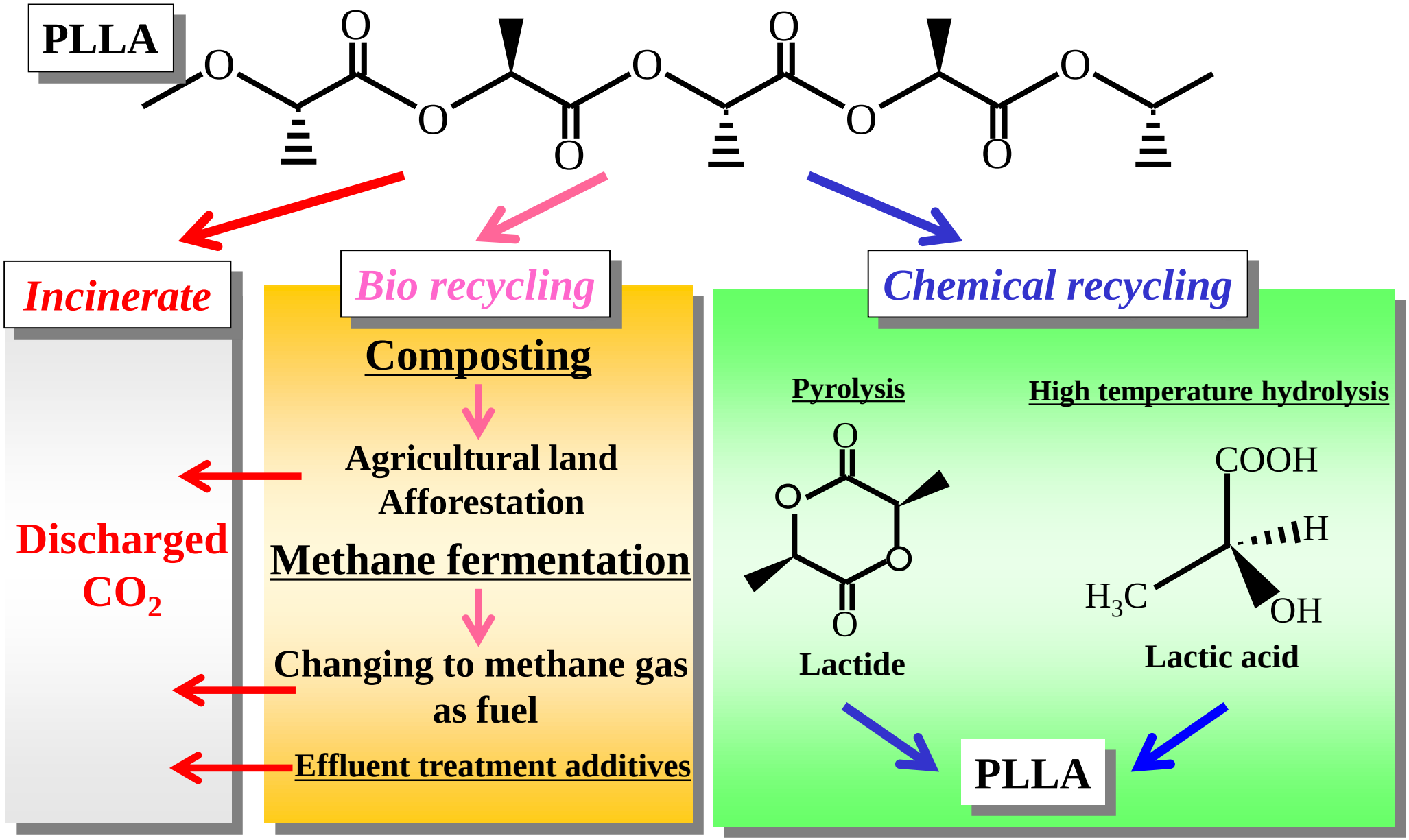


Figure2　Methods of treating (utilizing) PLLA

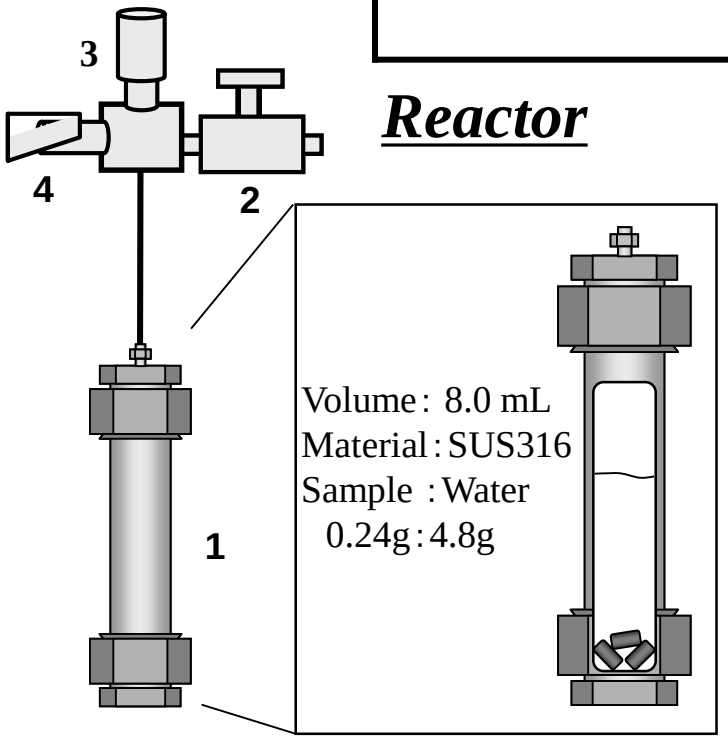
Experiment method

Sample：PLLA（L-isomer：98%, Molecular weight：2.0×10^5, Melting point：about 175℃）

Reaction conditions：

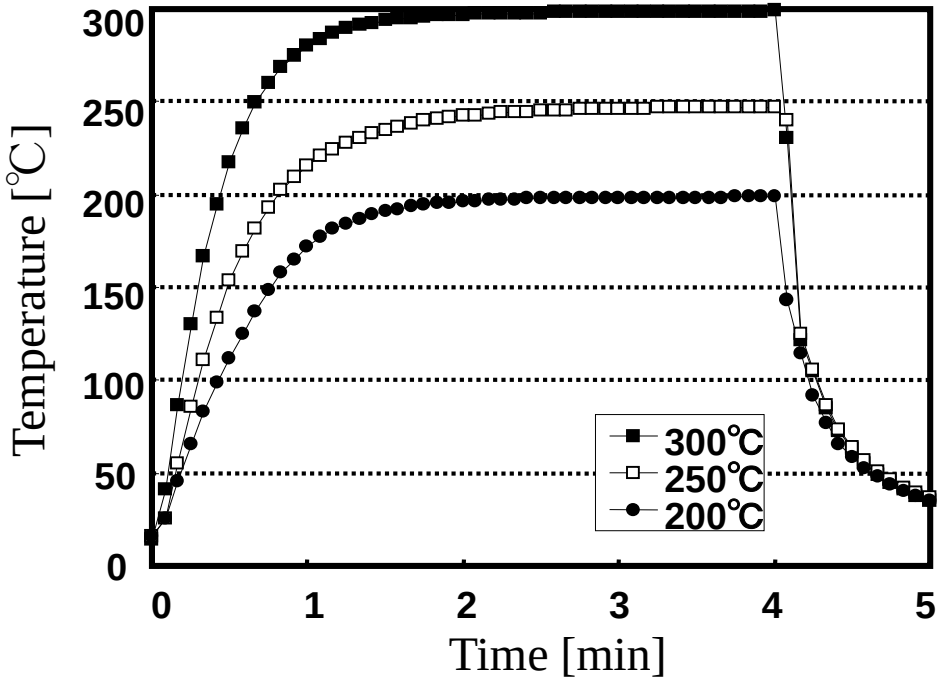
Reaction temperature	Reaction time	Reaction pressure	Sample (water)
180～300℃	1～180min	1.0～8.6MPa	0.24g：4.8g

Reactor

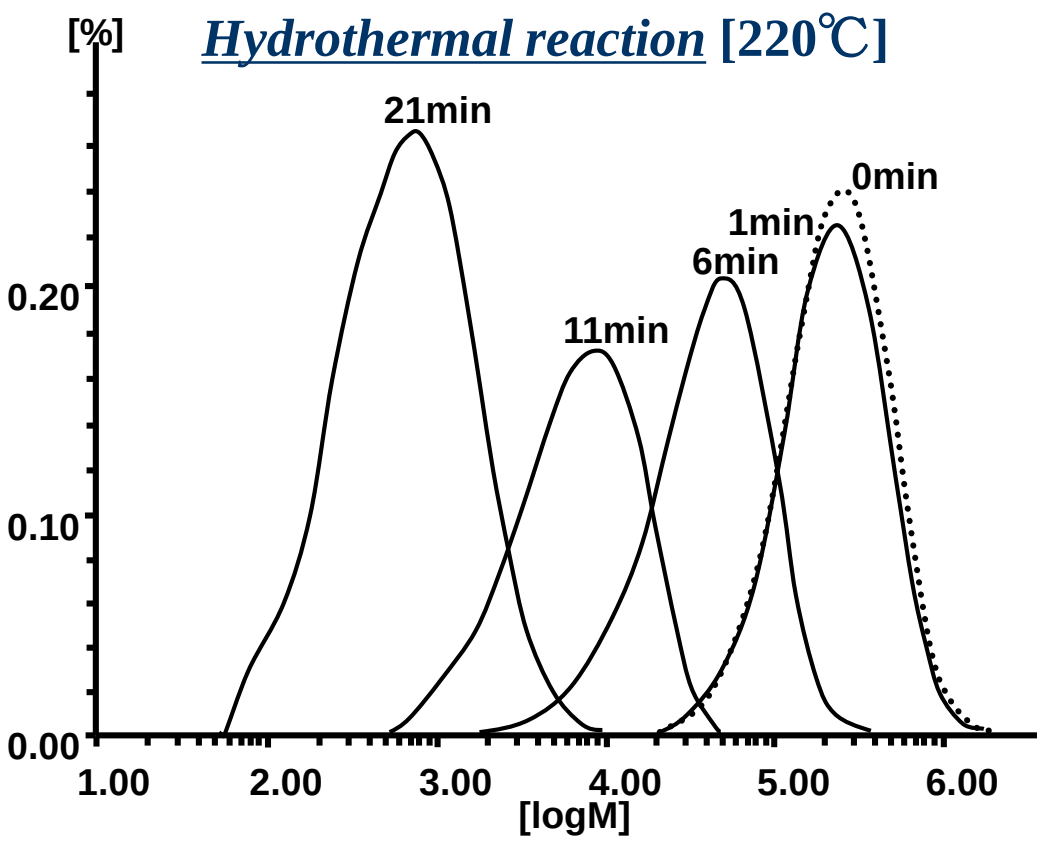


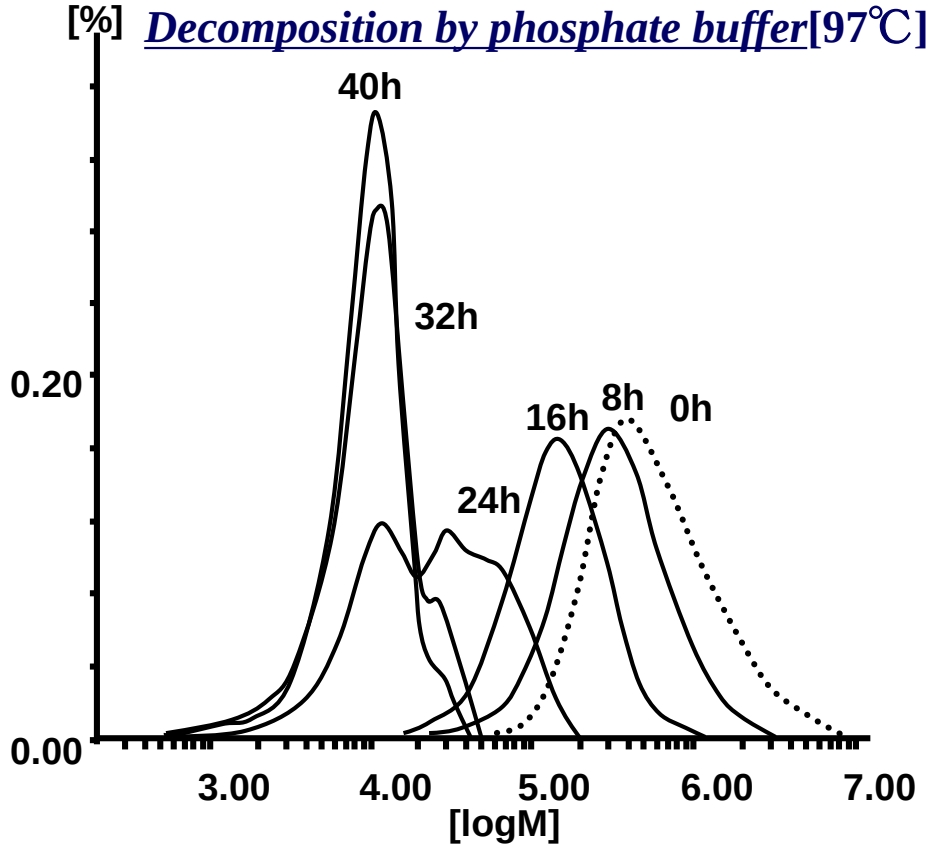
1. Reactor　2. Stop valve
3. Pressure sensor　4. Safety valve

Temperature changing in reactor



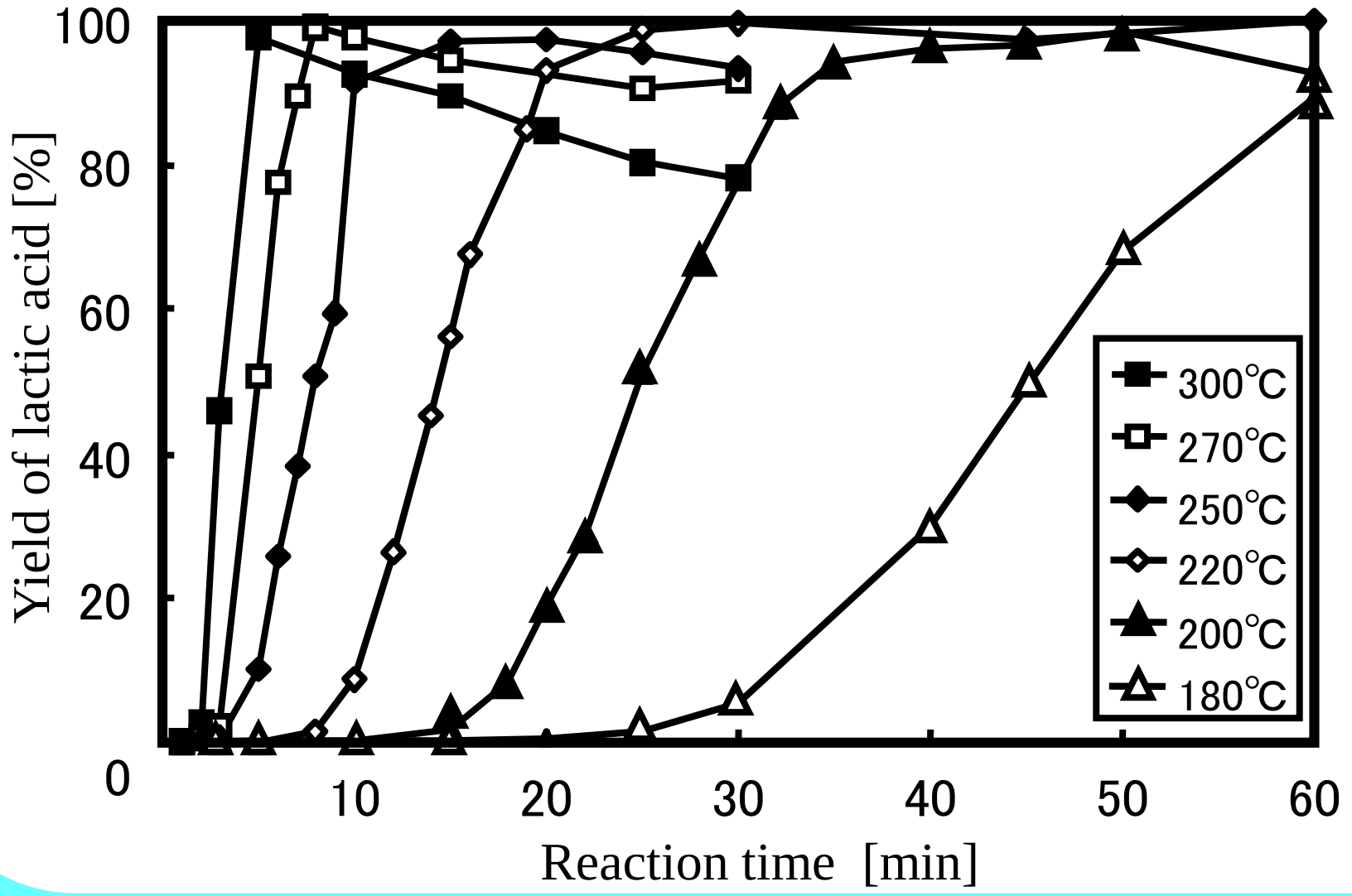
Comparing molecular weight of PLLA



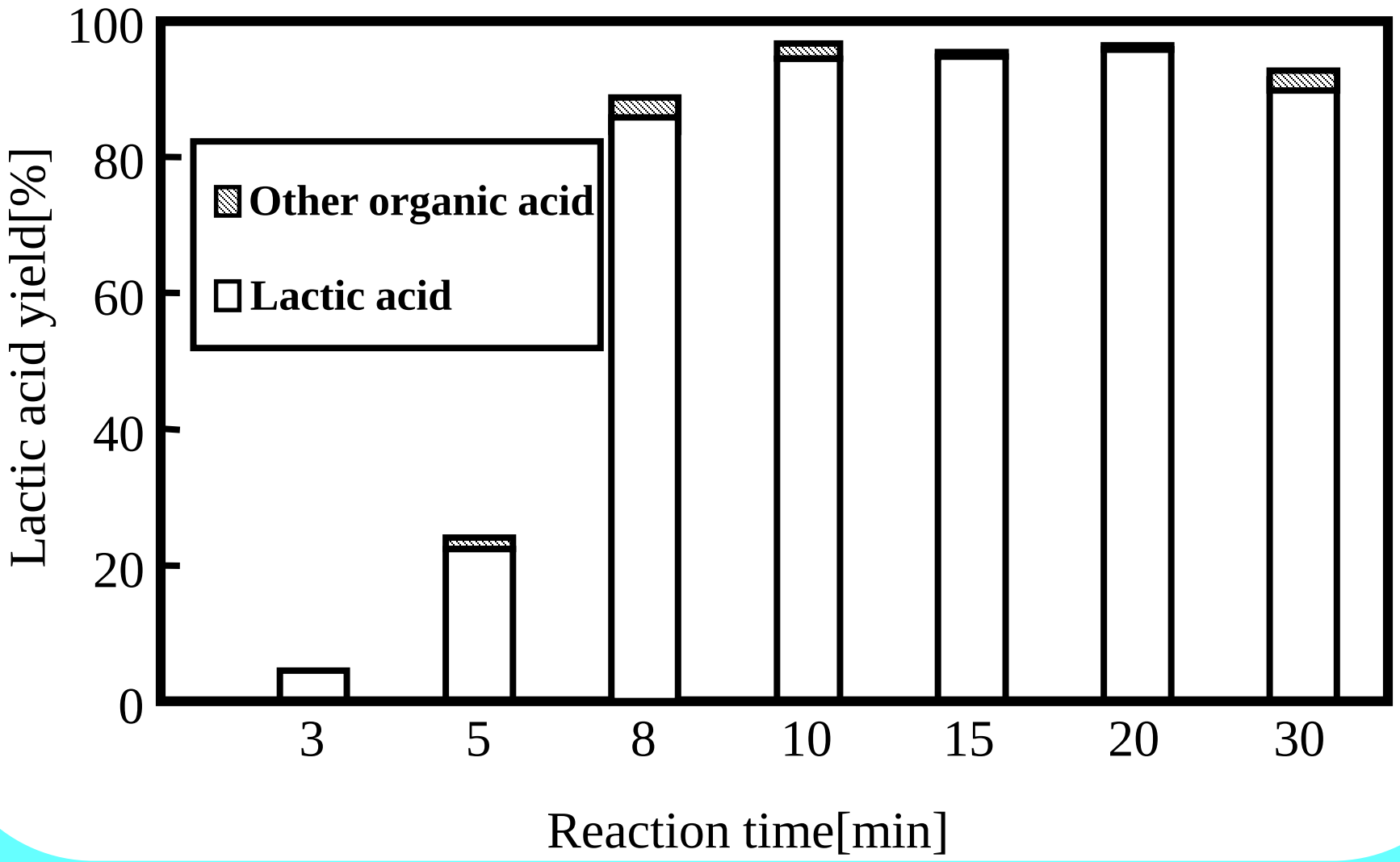


Remaining crystalline region in phosphate buffer.
Molecular weight degrade uniformly on hydrothermal reaction.

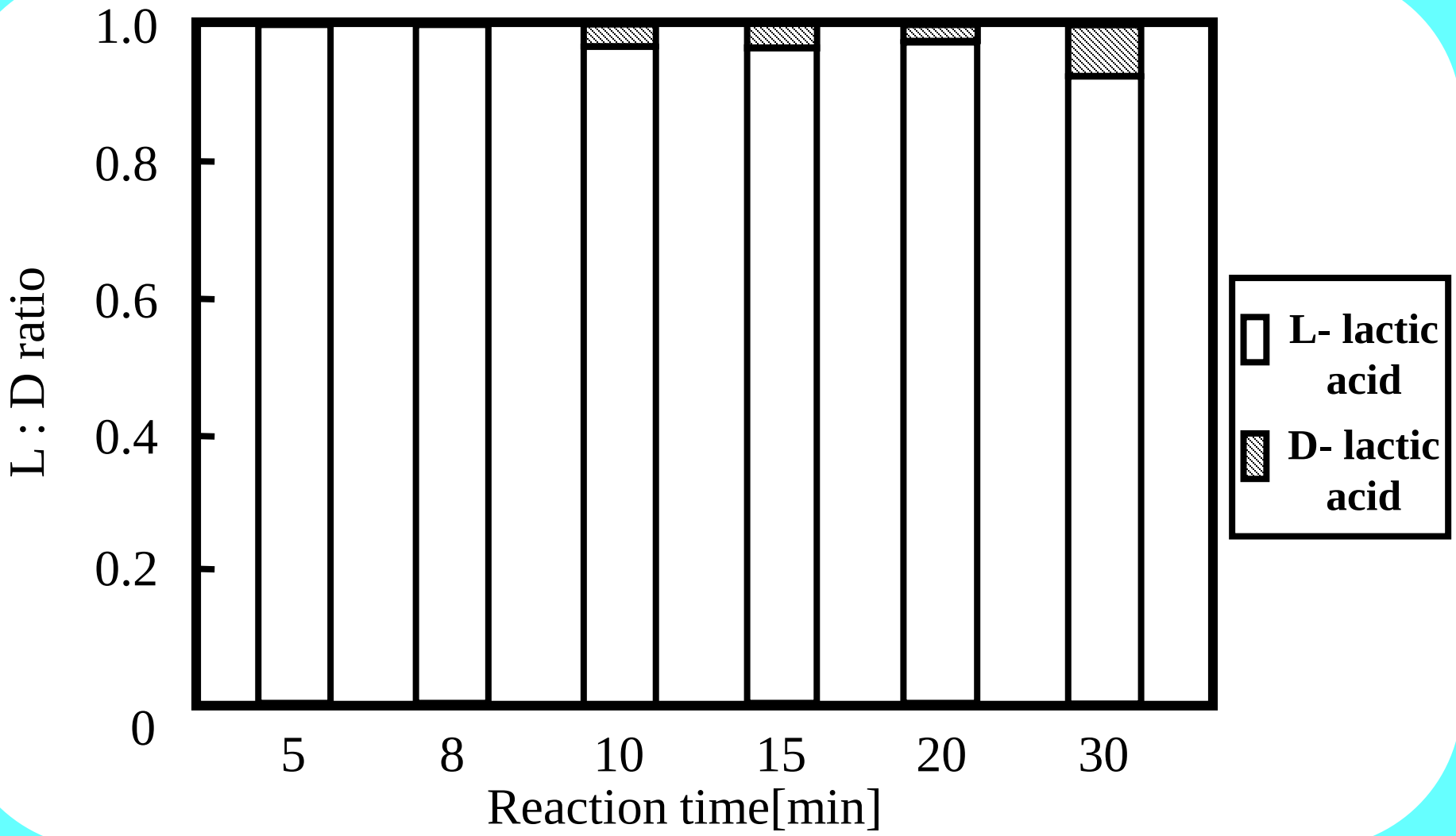
Impacts of temperature and time on yield of lactic acid



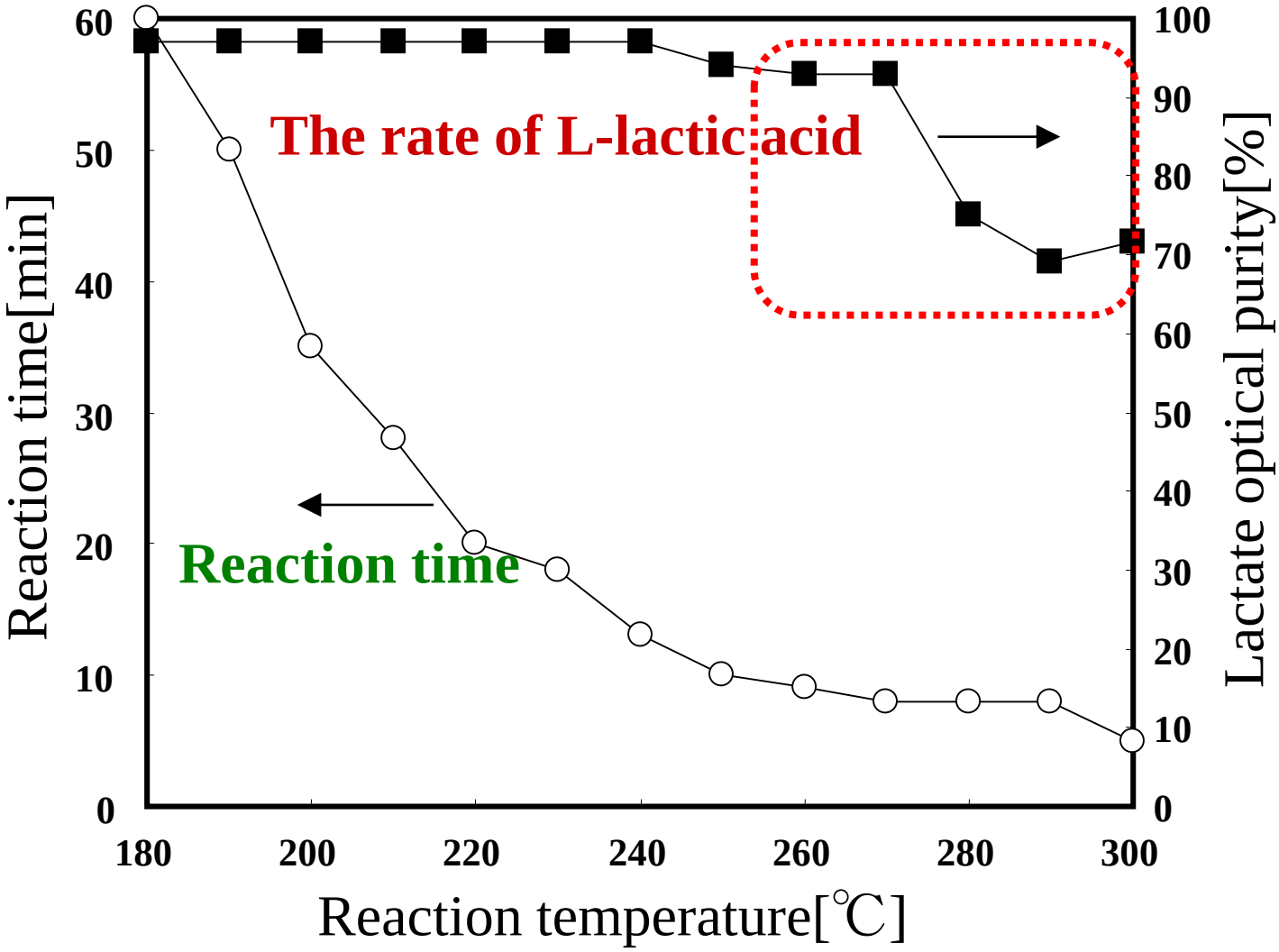
Relations of lactic acid and the byproduct at 250℃



Lactate optical purity at 250℃



Lactate optical purity with different reaction condition



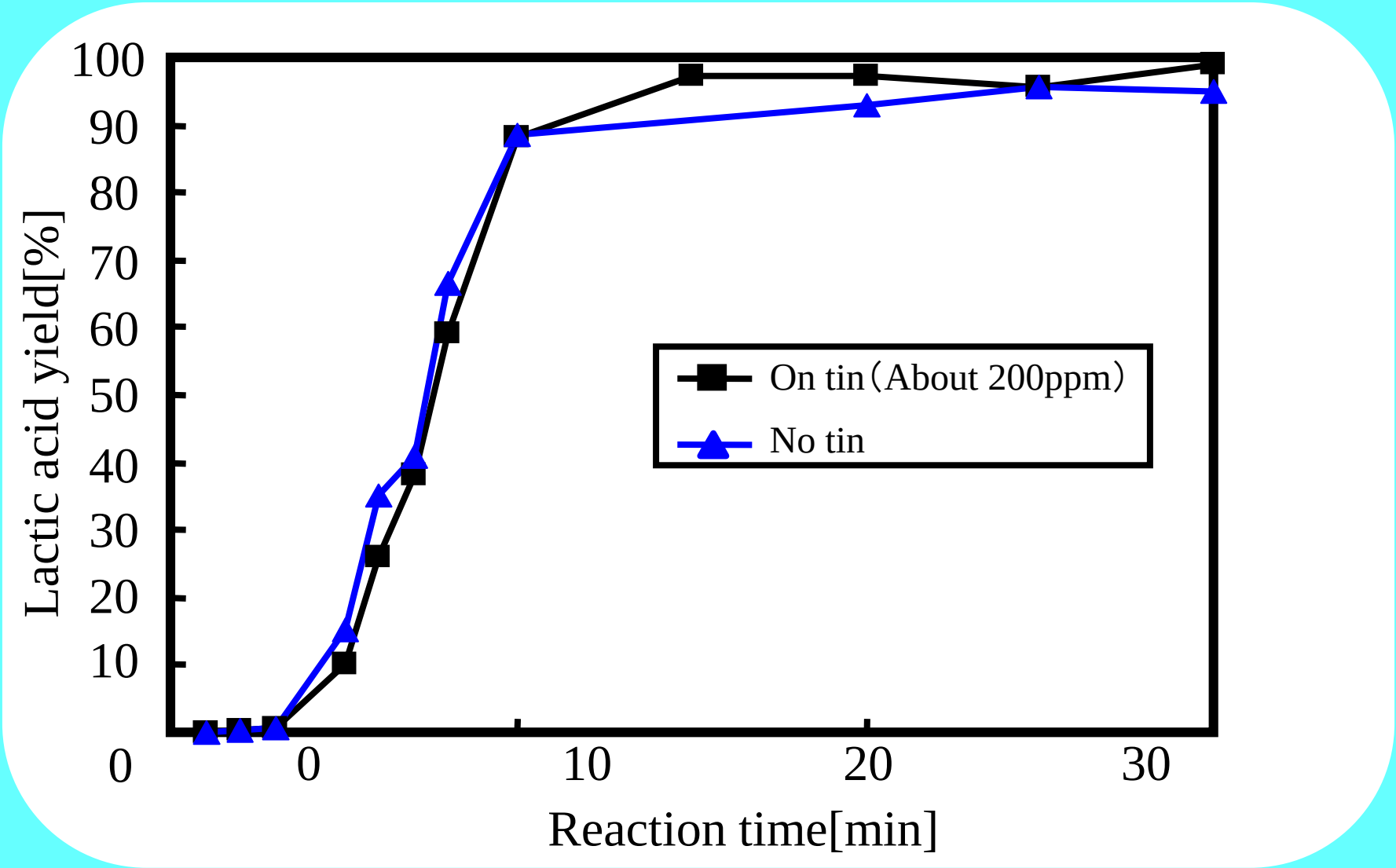
Reaction time:
The time when lactic acid recovery reaches 90% of reaction condition.

- **It is confirmed that lactate generated at a high temperature domain.**

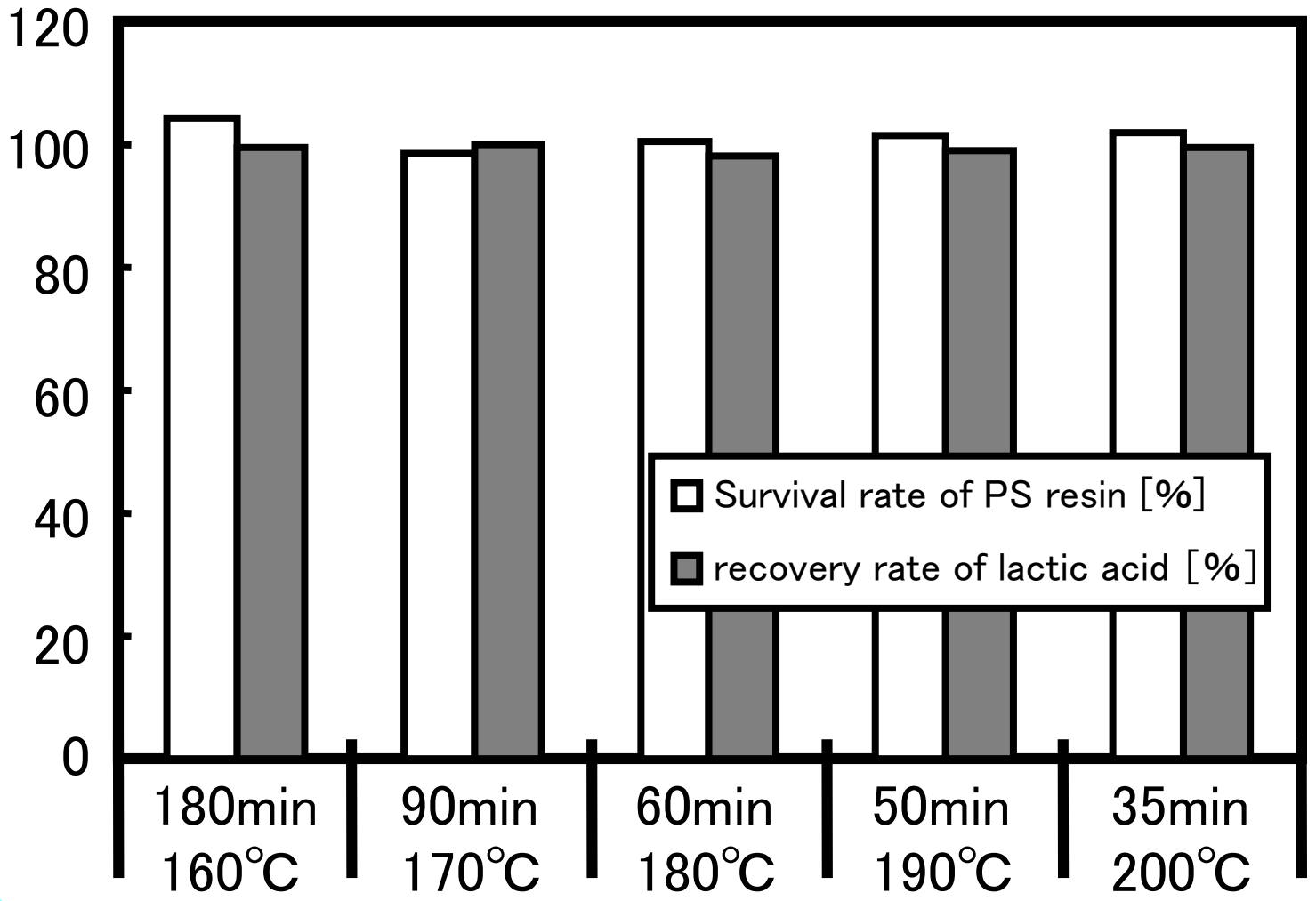
It can collect only L-lactic acid from polylactic acid at a high yield by reaction temperature of under 240℃.

Molecular weight of the sample : 130,000～200,000

Influence of the refinement of the polylactic acid by lactate yield（250℃）

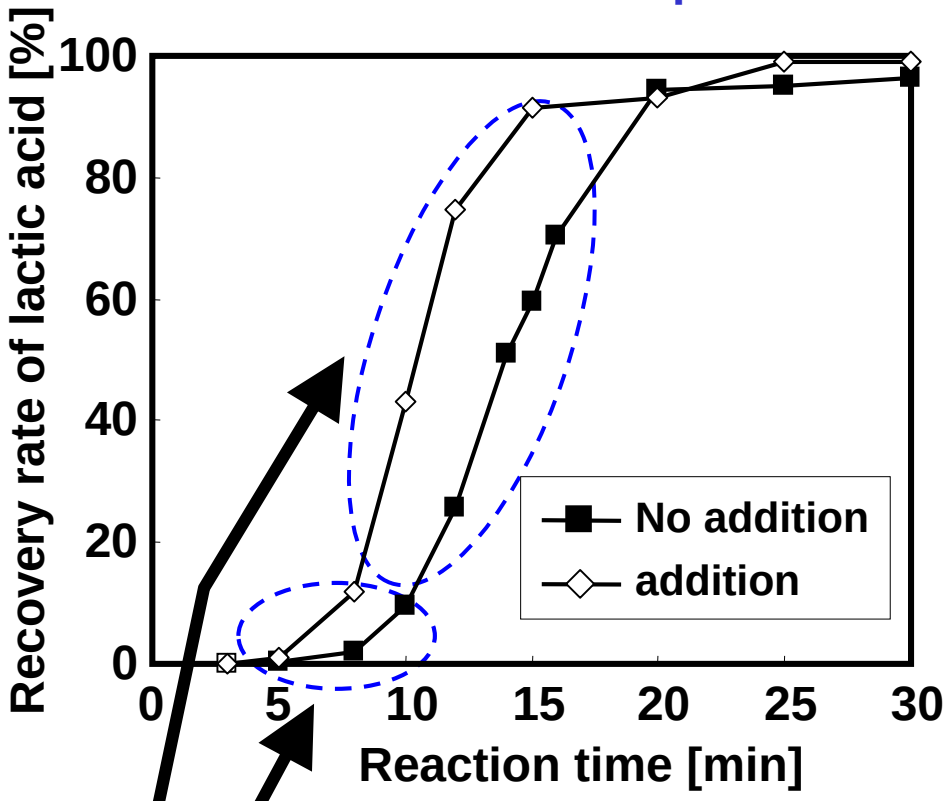


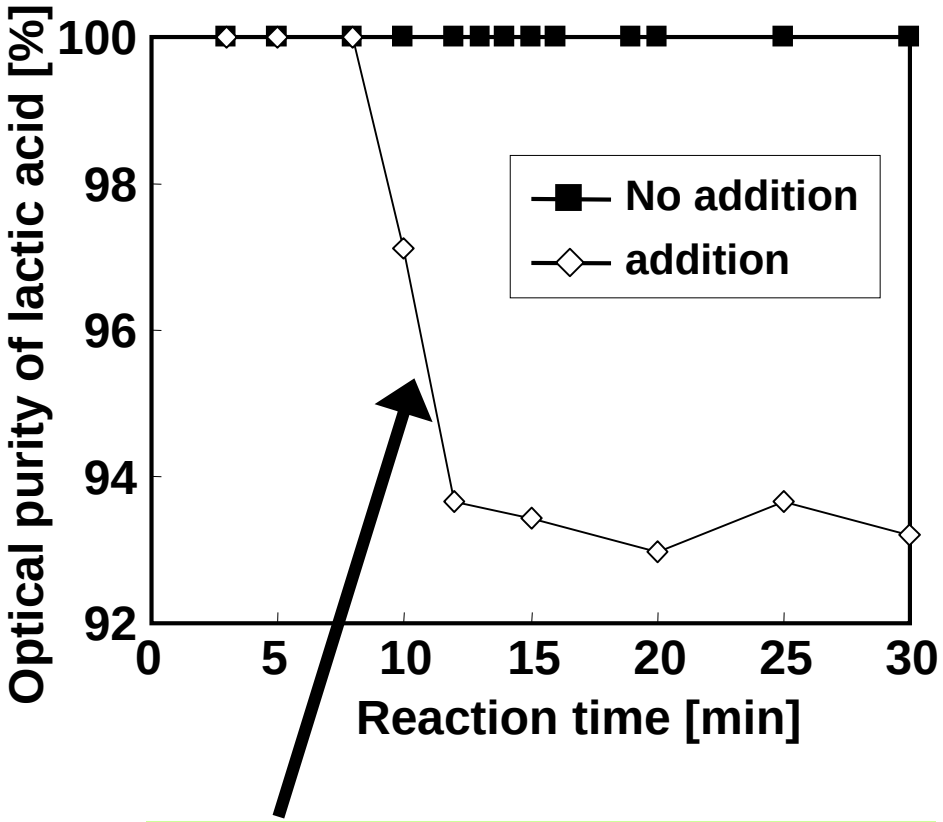
Residue ratio of PS resin and recovery rate of lactic acid when PS resin is added as mixture



Effects of mixture on lactic acid recovery （Aluminum hydroxide）

Reaction conditions：Temperature 220℃、Pressure 2.3MPa、Addition amount 40wt%





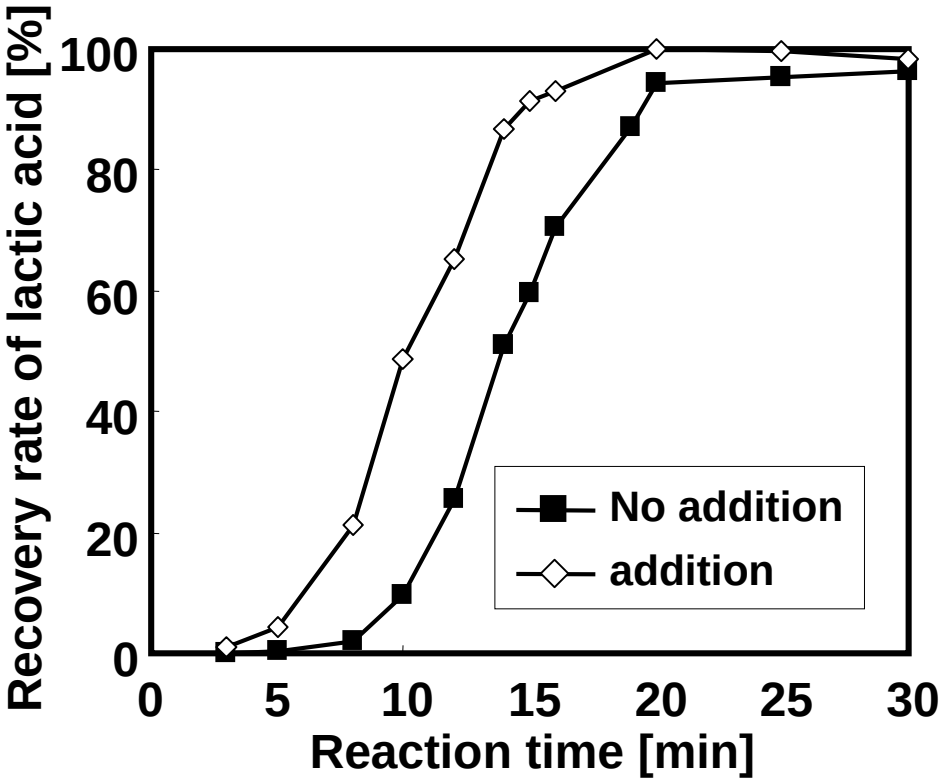
Difference of starting phase
Difference of generation speed of lactic acid

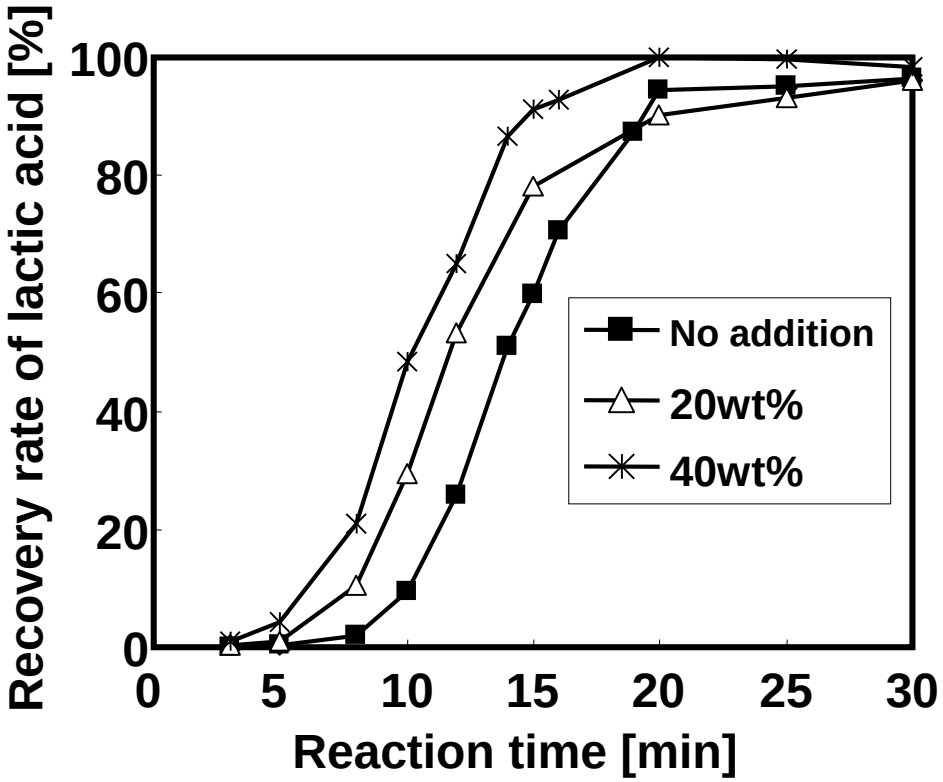
→Hydrolysis of polylactic acid promoted

Decrease of optical purity
→Caused by hydrolysis

Effects of mixture on lactic acid recovery (Magnesium silicate)

Reaction conditions: Temperature 220℃、Pressure 2.3MPa

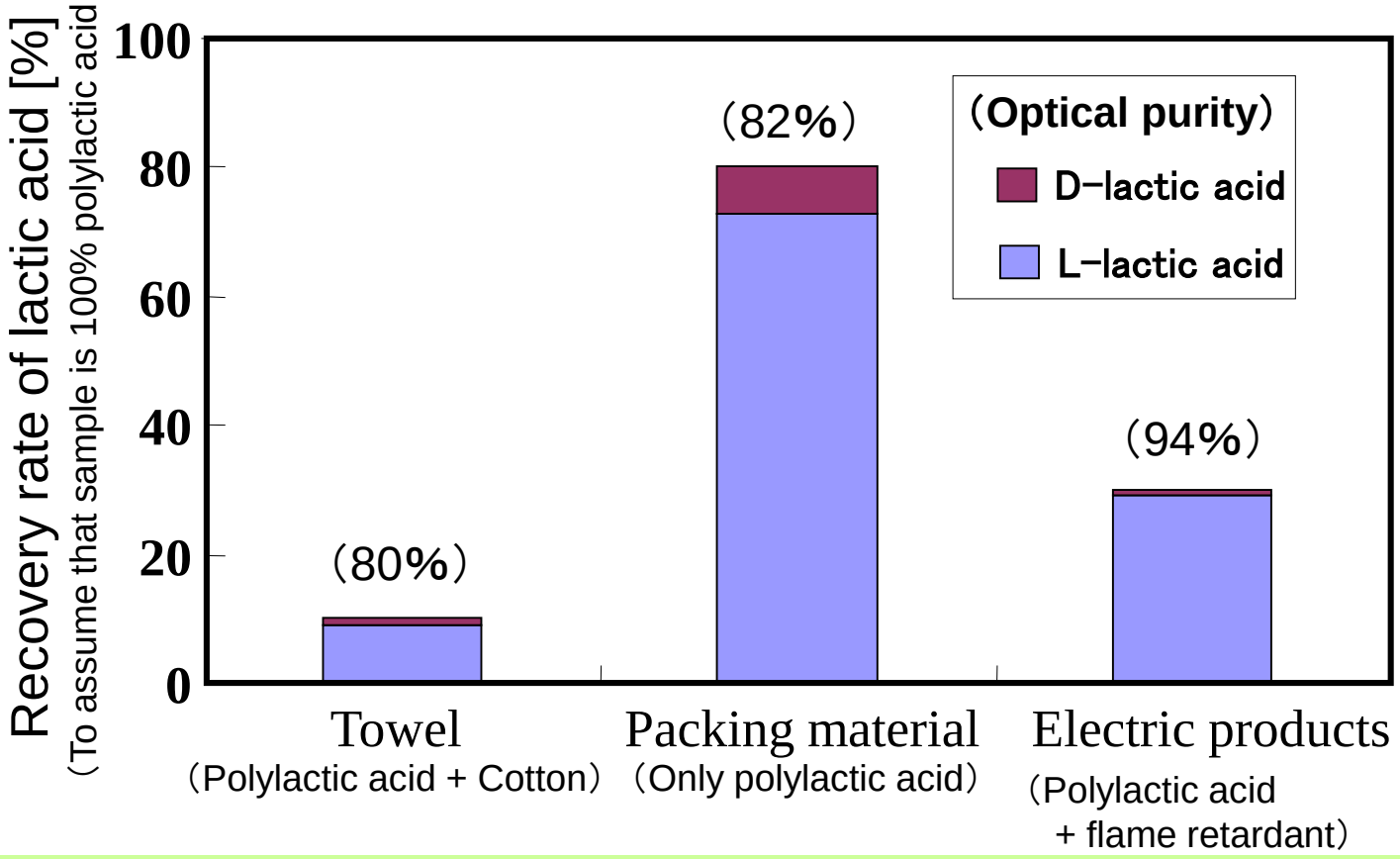


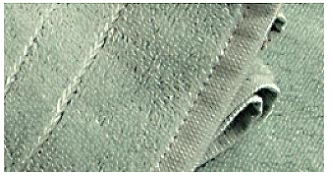


○Production of lactic acid promoted
（There's effect of addition amount）
○There is no effect on optical purity of lactic acid

Results of lactic acid recovery using real products

Reaction conditions：Temperature 220℃、Time 20min、Pressure 2.3MPa





Towel

Packing material

Electric products

○It is possible to recover lactic acid from each product.
○Decrease of optical purity confirmed.
→ It is necessary to study the effects on addition agent.

Summary

①produce lactate from polylactic acid ：random resolution、pyruvate

- ○High yield (more than 95%) is gained of 160~250℃
- ○The yield is not affected by properties of matter of the polylactic acid
- ○Not affected by the additive
- ○PET and separation of the PS are easy＞＞＞Probably kenaf as well

②Lactate optical purity

- ○Temperature less than 220℃ , prevent a lowering of the optical purity

Can collect a monomer having high purity in a high recovery

Existing separation, use of the refining method

The good teaching materials of the enlightenment activity

Hope for not only biodegradable plastic derived from biomass but also high recyclability plastic

Therefore classification collection !!

＞＞＞Recycling society construction promotion materials

Cargill  Toyota  ⇨ Polylactic-acid

Mass production difficult locally

Necessary for plant production

- Water: approximately 50～100t／t - plant
- Energy: oil
- Fertilize: oil
- Human and arable land

The future:

- Water shortage
- Abnormal weather
- Global warming
- Population increase
- Food problem

（0.05% of all corn , 350,000 tons）

- Mass cosumption
- Mass disposal

↓

Carbon dioxide

To make an EcoTopia

At present:

- The drying up of the fossil fuel？
- Lack of the last disposal ground？

- ○Review of the LCA evaluation
- ○Improvement of the onsciousness
- ○The circulation use of the polylactic acid
- ○Production in the country

Raw materials of the polylactic acid

- Food processing residual substance and waste water
- Cellulose and hemicellulose

＞＞＞The plural origin（Mitsui Chemicals）

Raw materials of PLA are made from rice in the country （Ministry of the Environment）

A part of the 21st century COE program "future social habits homeostatic engineering"

●The Kyoto protocol （since Feb,2005） ：USA、China 、India

In 2025 , global severe drought, the migration of nations

The issue of AIDS, hyperinflation, major earthquake

Drying up of crude oil and plant resources

●Zero-emission (the circulation use and outbreak source control)

●Even materials (trump) with concentrated wisdom are not perfect !

●The same as fund-raising on the streets ?

>>>The materials which open up the future

>>>Construction of a **new ethic (culture)**