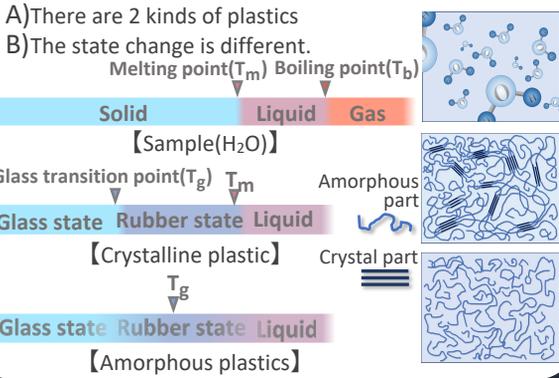


1) Purpose

- Reinforced plastics are less likely to be decomposed in the natural environment
- Photodegradation alone creates microplastics.
- To begin decomposition when exposed to UV rays, add material absorbing UV to biodegradable plastics.
- Select suitable biodegradable plastic.

2) Keywords



3) Biodegradable Plastics

- Easy to create
- Popular among biodegradable plastics

Poly(lactic acid) (PLA)
Made from Lactic Acid

There are 2 optical isomers of lactic acid.
Mix L:D=1:1 = LD-lactic acid
The nature changes by the mixing ratio.

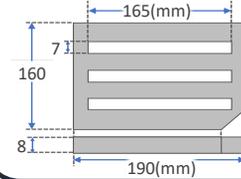
Name	L-lactic acid	D-lactic acid	LD-lactic acid
Name of resin	PLLA	PDLA	PLDLA
Type	Crystallinity	Crystallinity	Amorphous

PLLA/PDLA ... Because of the same structure, crystallization.
PLDLA ... Because different structures are mixed, amorphous.

4) Preparation of Pellets

[Materials (Excerpts)]

	50%	96%	100%
L-lactic acid (ml)	50.0	4.0	0.0
LD-lactic acid (ml)	0.0	46.0	50.0



[Method]

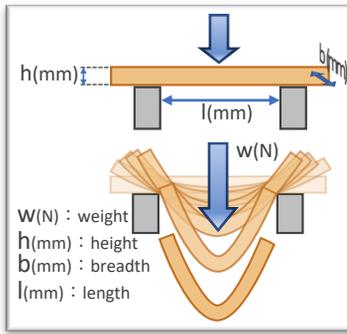
- Prepared lactic acid including L-lactic acid 50%, 96%, 100% (about 1 hour)
 - Heated from 21°C to 230°C. (about 1 hour)
 - Maintain at 230°C ~ 250°C. (about 30 minutes)
 - Natural cooling in the mold
- * 1:D-lactic acid content $1.5 \leq X_D \leq 5.0\%$ is common.
(The source "PLAのL体とD体について - Nature3D")

5) Experiment

[Experiment (strength)]

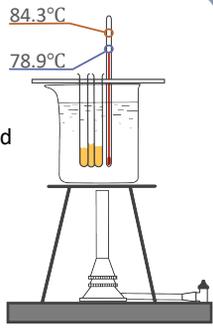
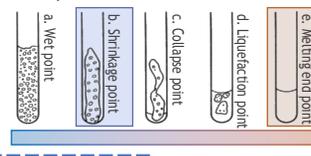
- Three pellets created are installed. (see right)
- Strength is applied from the top on the center, and strength is increased.
- Measure the force when the pellet falls and use the following formula to determine strength (σ).

$$\sigma = \frac{wl/4}{bh^3/12} \times \frac{h}{2}$$

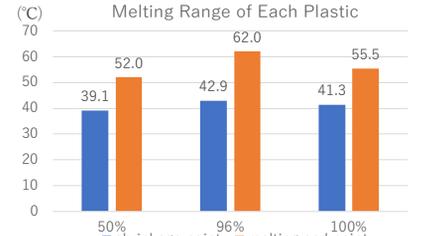
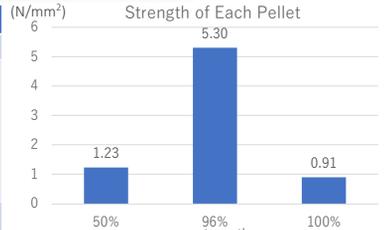


[Experiment (melting range)]

- Three pellets were crushed into powder.
- Each is packed into a test tube.
- Created a device (see right), and heat it.
- Among the states shown below, measured the temperature at "b" and "e".



Pellets	50%	96%	100%
weight (kg)	0.789	2.346	0.590
photos			
σ (N/mm ²)	1.23	5.30	0.91



6) Consideration

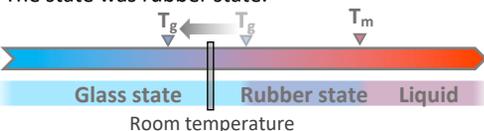
- All three pellets have the spinnability*2 at 80°C.
It has become a polymer (or oligomer).
- All three pellets are transparent (Brown).
When there is a crystal part, it absorbs light.
In PLLA, percentage of crystallization is small.
PLLA is substantially closer to amorphous plastic.

*2 : The nature of pulling strings.
It caused by the entanglement of polymers.

[Hypothesis In fact]

Pellets	50%	96%	100%
Type	Amorphous	Crystallinity	Crystallinity
Features	flexible	sturdy	hard and brittle flexible

- The glass transition point was lowered.
- The state was rubber state.



- Not easy to come loose. T_g UP.
- Easy to come loose. T_g DOWN.
- When the degree of polymerization is low, the crystal layer becomes thinner.
 T_g became down.
- The melting range is close though there is a difference of the crystal structure.
There were few crystals in the first place.

7) Future Research

- I'll use L-lactic acid 96% as biodegradable plastic because it is sturdy.
- The UV absorbing material is added to the PLA of L-lactic acid 96%.
- Compare melting point, strength, and degradation in seawater.
- Investigate the impact on marine life.