Development of Photo-Switching Ocean-Degradable Plastics with Edibility

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R & D items

② Construction of OFF type photo-switch system by antibacterial action under indoor light or sunlight

②-2 Composite of marine biodegradable plastics and antibacterial photocatalyst

③ Evaluation of biodegradation of photo-switching marine biodegradable plastics in real marine environment

③-2 Seawater biodegradation and safety assessment by laboratory test: BOD test

④ Evaluation of Biodegradation and safety of photo-switching marine biodegradable plastics in a simulated laboratory environment

④-1 Hydrolyzation with digestive enzymes

④-3 Evaluation of Biodegradation and safety tests using fish

Development of OFF-type photo-switching biodegradable material

Photocatalyst

Biodegradable plastics

OFF-type photo-switching biodegradable materials

Film
Sheet
Dumbbell
Fiber
Non-woven fabric

Performance evaluation

ON/OFF double switching materials

Multilayered film
Core sheath structural fiber

Biodegradation of materials equipped with photo-switches

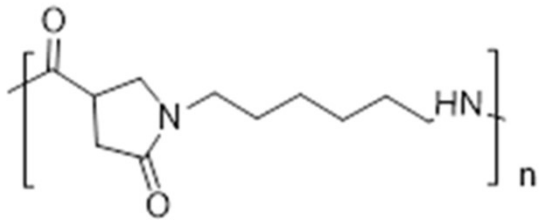
	Mechanical properties	Living environment	Marine (Sea surface)	Marine (Underwater)	Marine (Sea surface) After long time
ON type	high	No biodeg.	Biodeg.	No Biodeg.	Biodeg.
OFF type	low	No biodeg.	No biodeg.	Biodeg.	Biodeg.
ON/OFF type	high	No. biodeg.	No biodeg.	Biodeg. (Maintaining strength)	Biodeg. (Maintaining strength)

Various pattern to turn on the biodegradation switch depending on the environmental conditions, combinations, and compositing will be selected.

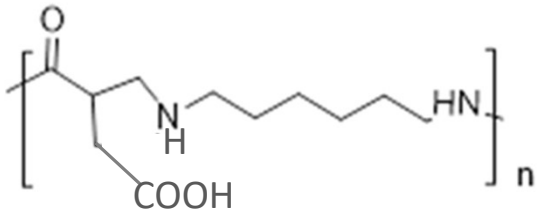
②-2Construction of OFF type photo-switch system by antibacterial action under indoor light or sunlight

Biodegradation Labo test (BOD) /ON type（before switch on)

Ny6i：

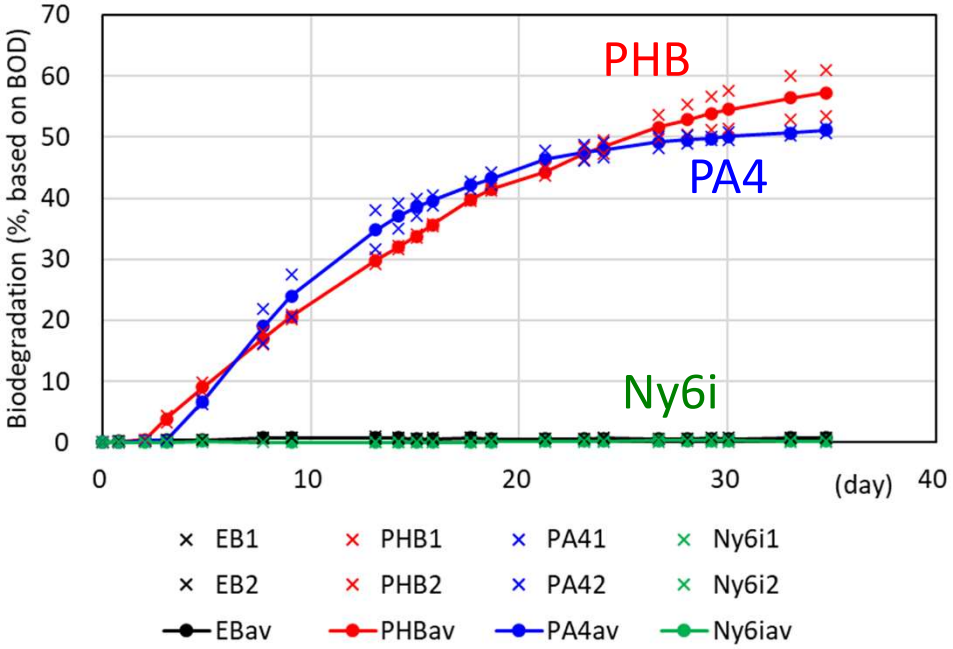


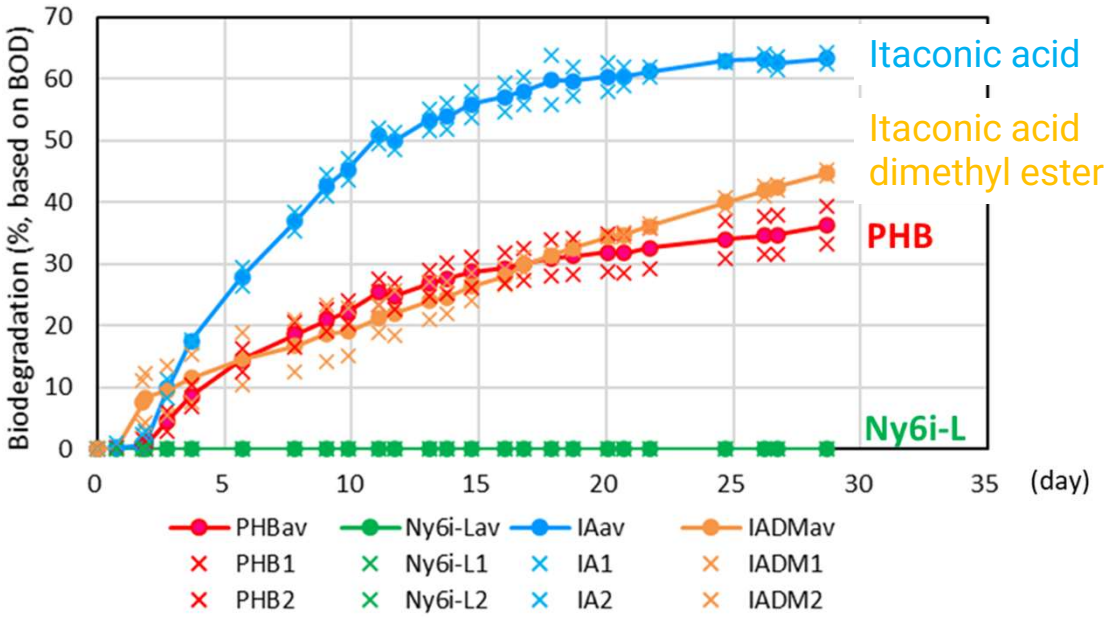
closed type
(Ny6i-c)



ring-opened
(Ny6i-o)

Biodegradation reaction $C_{11}H_{18}N_2O_2 + 17\ O_2 \rightarrow 11\ CO_2 + 8\ H_2O + 2\ HNO_3$



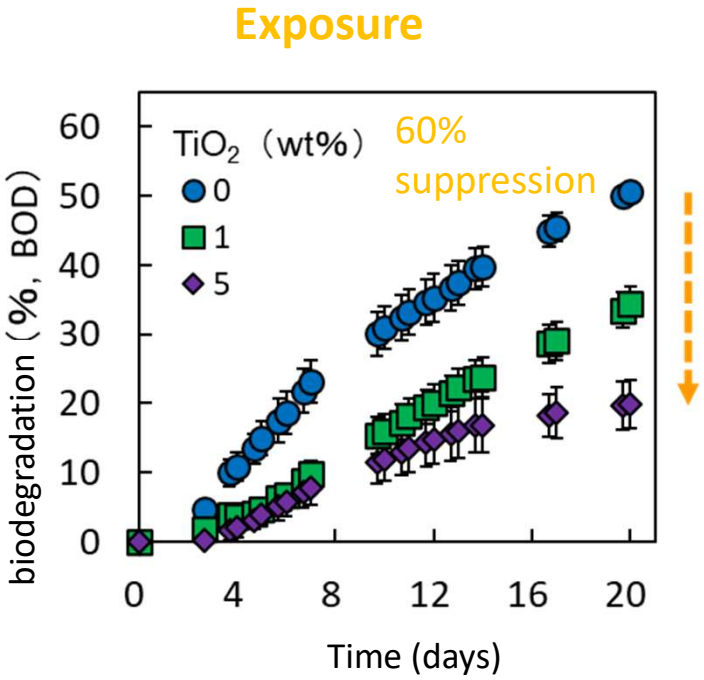


In the ring-closed type before the switch is turned on, biodegradation hardly proceeds even if the molecular weight is low.

Monomer components (itaconic acid, itaconic acid dimethyl ester) are biodegraded.

Seawater biodegradation test under exposure (BOD) /OFF type

Light irradiation seawater biodegradation measuring device



Goals

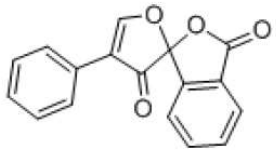
Extraction of various factors such as light that affect marine biodegradation

Analysis of decomposition products and clarifying the profile of the resin decomposition process

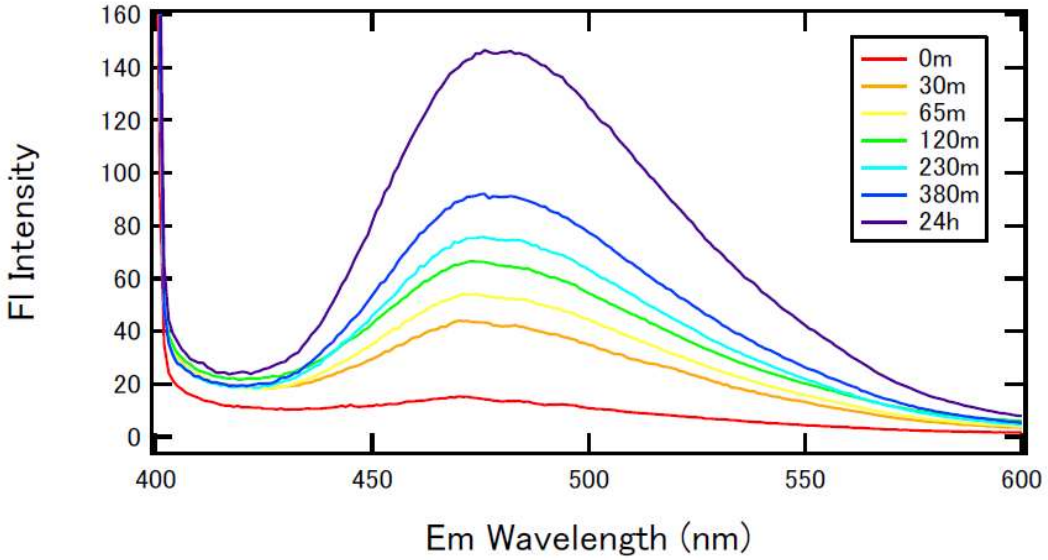
Enzymatic hydrolysis test

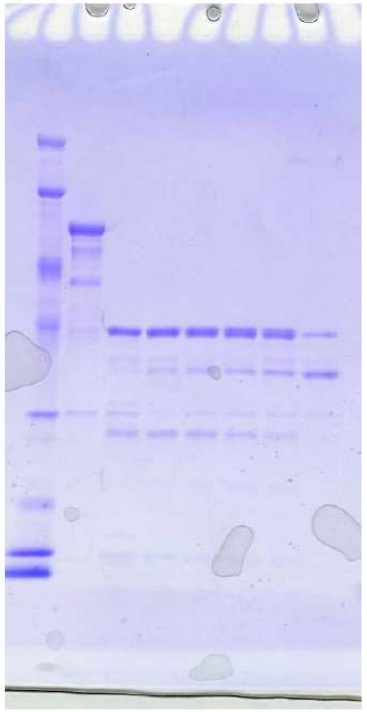
Construction of enzymatic hydrolysis method by spectroscopic method

A method for detecting amino groups (derived from a produced new N-terminal) that increase with the degradation of proteins by proteases by fluorescence of fluorescamine.



Fluorescence intensity increases with protein degradation
Spectroscopically monitor the enzymatic decomposition of macromolecules

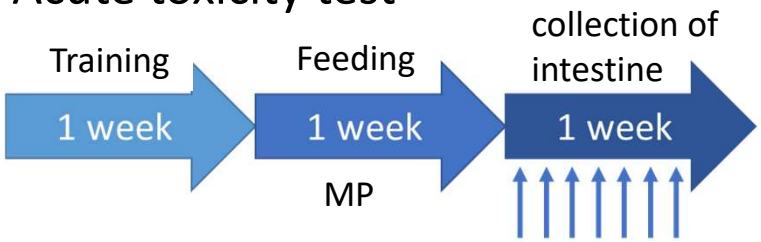


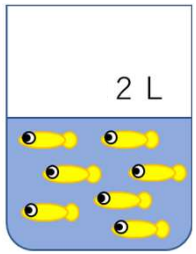


Goals
Quantification of hydrolysis by digestive enzymes
Clarification of the effect of polymer chain structure on enzymatic hydrolysis
Elucidation of the effect on the enzyme reaction due to the structural change before and after light exposure

Evaluation of Biodegradation and safety tests using fish

① Acute toxicity test





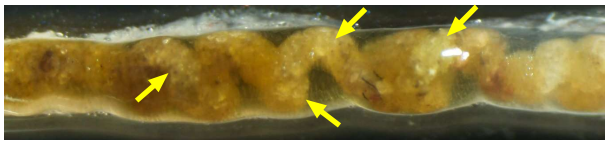
fish: 7

feed 7.3mg/fish/day
MP 3.7mg/fish/day

MP	Acute toxicity
PS	none
Ny6	none
Ny6i(1%TiO2)	none
Ny6i(trimer)	none

＜Excised intestine: MP＞

PS（14days）



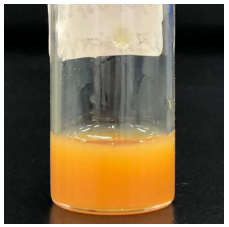
Ny6i trimer (8days)

In case of PS, MPs were remained in the intestine on the 14th day, but Ny6i trimer did not remain on the 8th day.

②Biological effects of microplastic intake

Preparation of feed with microplastics
↓
Feeding (1 month)
↓
RNA sequencing analysis of intestinal expression genes

＜Preparation of feed with Ny6i＞

Ny6iL	Ny6i(0.5%TiO2)	Ny6i(1%TiO2)	Ny6i,trimer
			
solid	paste	powder	powder
			

Goal

Acute toxicity assessment of biodegraded intermediates will be performed.
Safety and digestion of resins and degraded products in guppy gastrointestinal tract.


MOONSHOT
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