Development of Non-Food Biomasses Based Biodegrade Rubber Compound in Wear Particle for Tire

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Bridgestone Corporation
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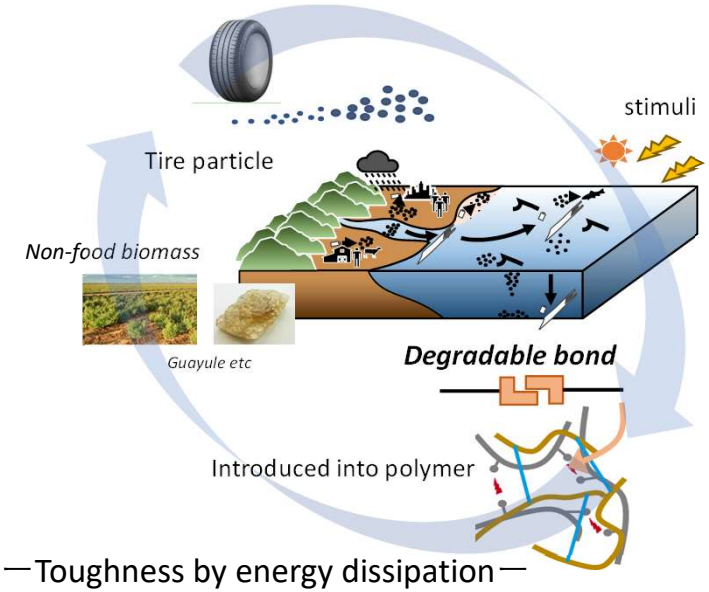
MS伊藤PJ

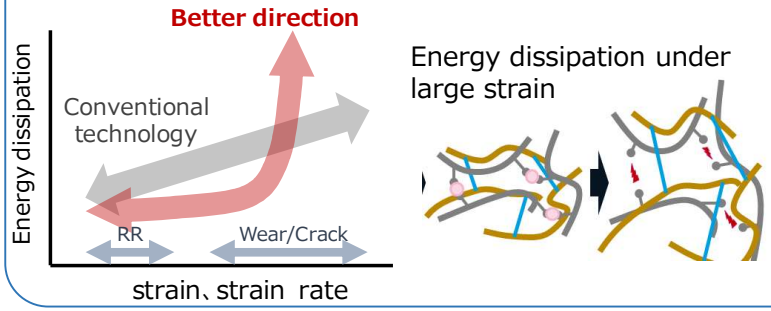
【Contents】We are trying to develop non-food biomasses based multi-lock tough polymer which can be decomposed by multiple stimuli. Combined with the toughness technology by energy dissipation cultivated in ImPACT project (2014-2019), the developed tough polymer is applied to tire tread, and it demonstrates toughness by energy dissipation in use and quickly decomposes by multiple stimuli (microorganism and combination of light, heat, oxygen, etc.) after use in the state of wear particle. Tires that have less influence on marine microplastics will be expected.

【Progress】This theme consists of (1) development of non-food biomasses based biopolymer synthesis, (2) development of multi-lock degradability technology and (3) development of degradability evaluation method/degradability behavior analysis method. In collaboration with academia which develops common basic technology, we are proceeding with studies on toughness by energy dissipation and biodegradation.

—Biodegradation cycle of tire wear particle—



—Toughness by energy dissipation—



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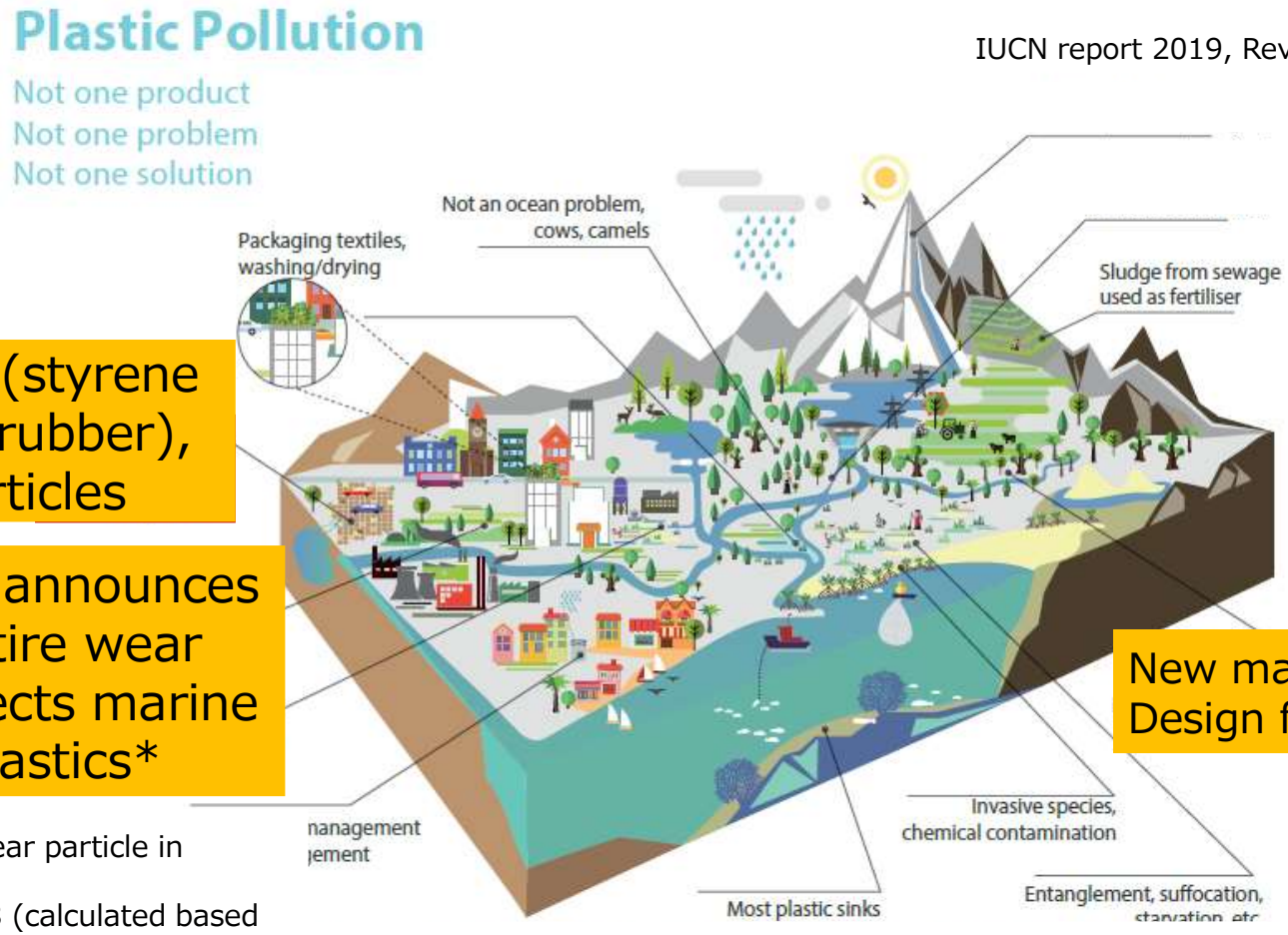
Influence of tire wear particle to ocean

IUCN report 2019, Review of plastic footprint methodologies page3



Tires, SBR (styrene butadiene rubber), nanoparticles

This report announces that the tire wear particle affects marine microplastics*

New materials, Design for recyclability

*The ratio of tire wear particle in microplastics :
・47% in UNEP 2018 (calculated based on the listed figures)
・28% in IUCN 2019

Figure : Plastic leakage from source-to-ocean

Environmental groups and reports → it is pointed out that tire wear particle is left in the environment. Technical development is desired from a view of environmental pollution/circulation of resources.

The title of this project “Development of Non-Food Biomasses Based Biodegrade Rubber Compound in Wear Particle for Tire”

Purpose

To reduce negative impact of tire wear particle to ocean

In use
“Toughness”

Trade-off

After use
“Degradability”
“Non-food biomass”

Development contents

Development of polymer and tire highly balancing toughness and degradability utilizing non-food biomasses

Solution method

Non-food biomass

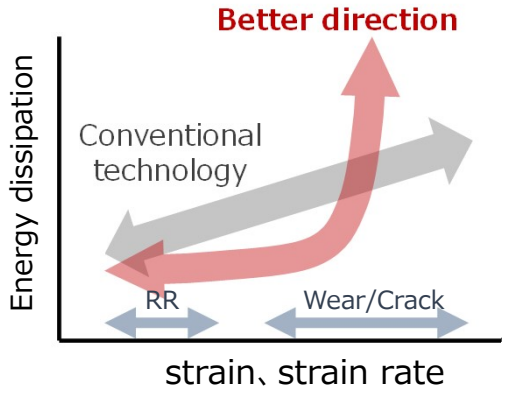
Adopting diversified natural resources

Guayule,
natural rubber

Biomonomer
×diene rubber

Toughness

Energy dissipation technology developed in ImPACT Project

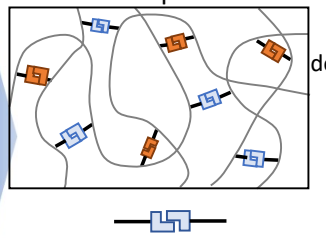


Effective energy dissipation under large strain

Degradability

—in use —

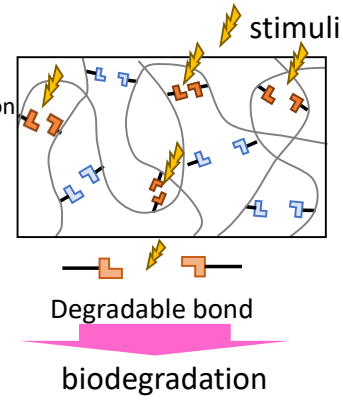
Toughness by energy dissipation



Energy dissipation bond

—after use —

Multi-lock mechanism



We will propose a new biodegradable polymer by multiple stimuli after use.

Approach by academia collaboration and target

Biopolymer

-Academia collaboration-

Development of biopolymer synthesis

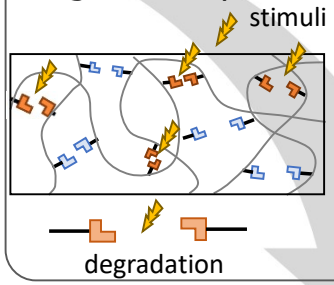
Non-food biomass

diene rubber

Multi-lock Mechanism

-Academia collaboration-

Development of multi-lock degradability technology

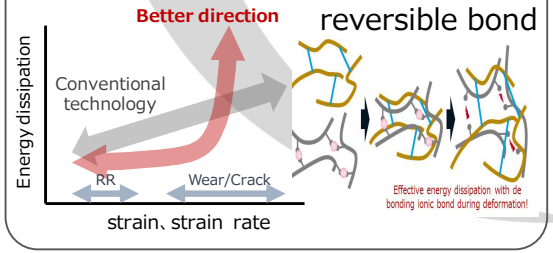


Toughness

-Academia collaboration-

Development of toughness

Energy dissipation by DCL concept

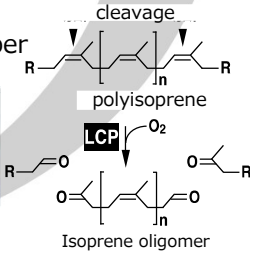


Degradability Analysis

-Academia collaboration-

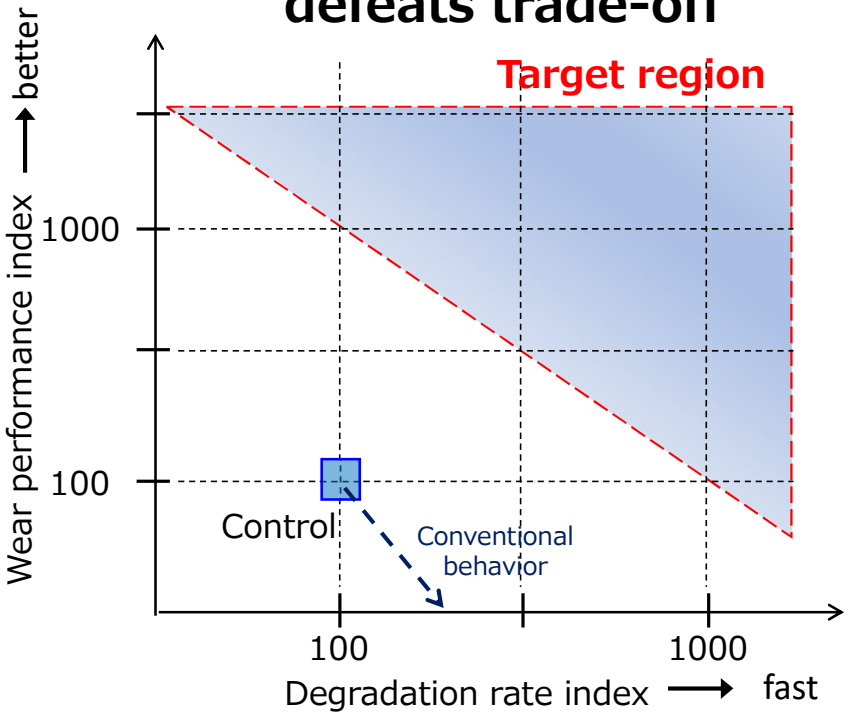
Development of degradability analysis method

Degradability of rubber



【Final Target】

"Dan-Totsu" innovation defeats trade-off

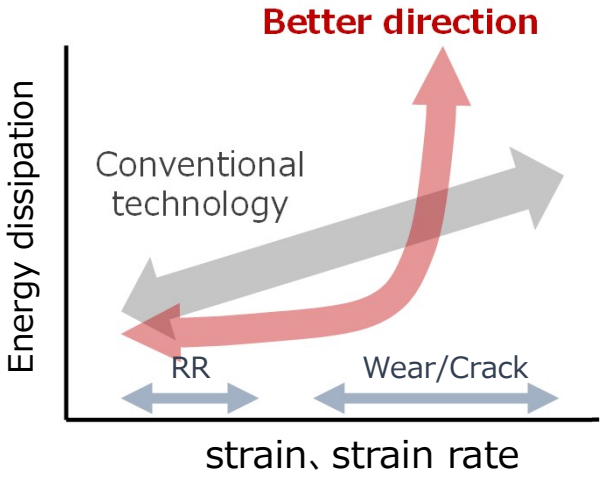


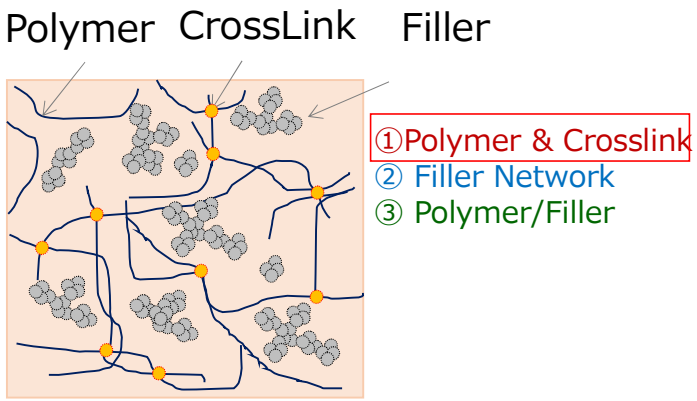
【Target】
Improvement of Wear performance/degradation rate balance ⇒ ＜10 times

Proof of degradability
Highly balancing degradability and toughness

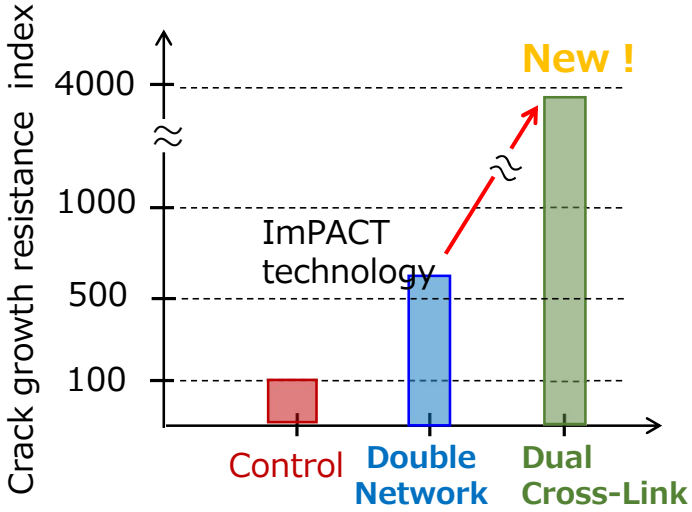
Progress: Development of DCL (POC of improved wear)

Toughness

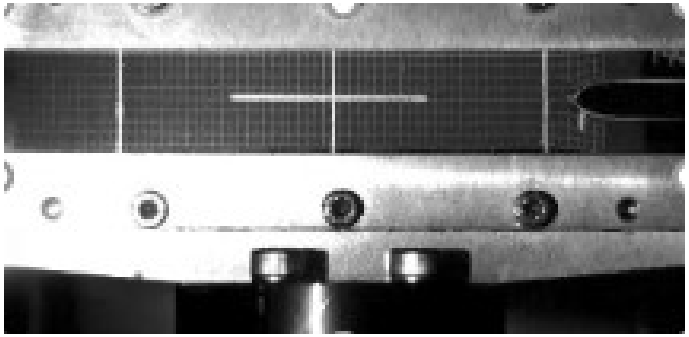


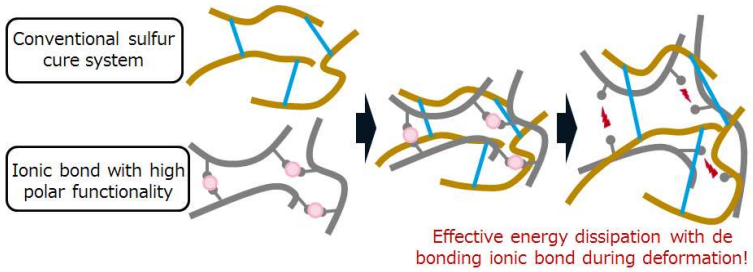


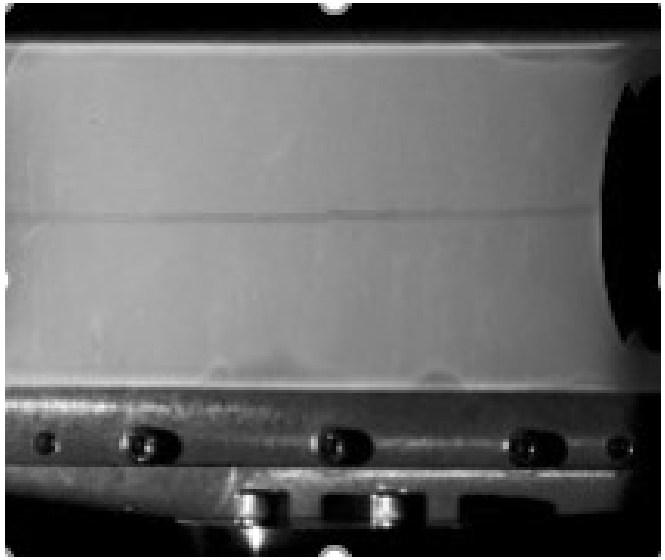
Rubber Compound for tire



Improvement from ImPACT Program, high toughness by adopting DCL concept



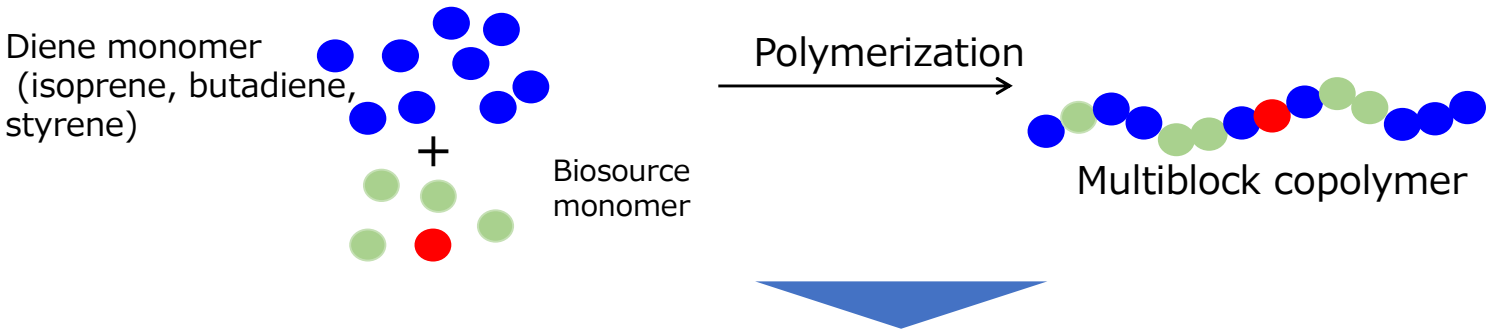




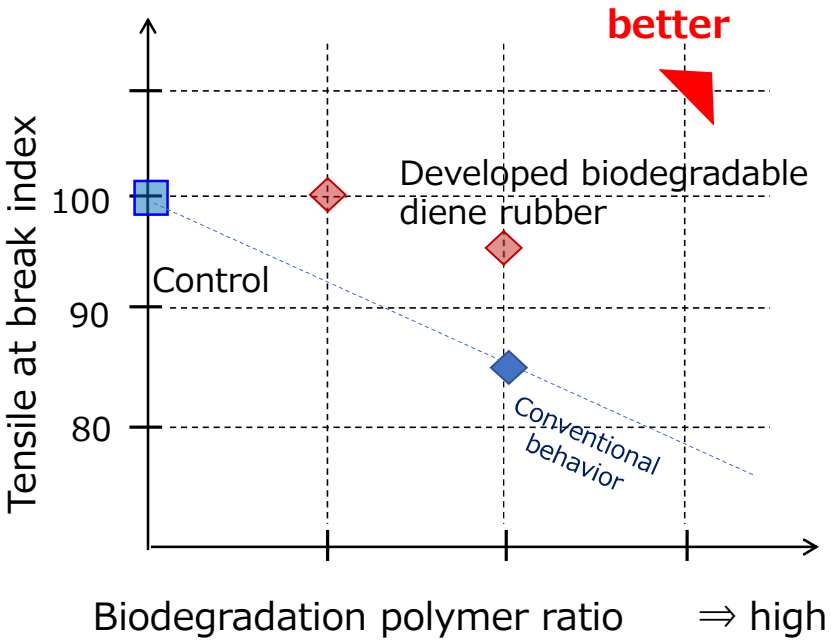
Application of Dual Cross-Link

Progress : Development of Biopolymer (POC of biodegradation)

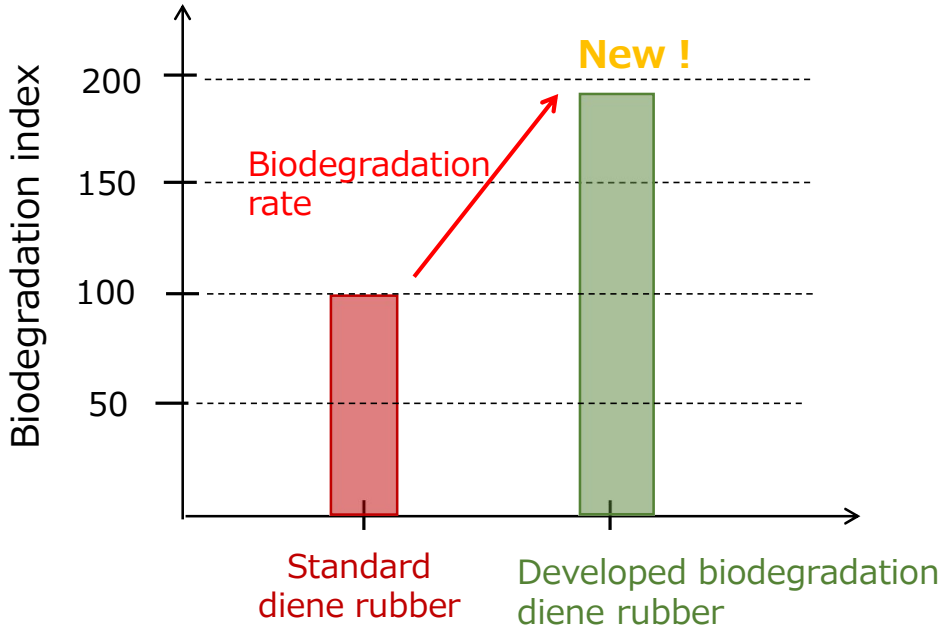
Biopolymer



【Result of Physical property】



【Result of biodegradation】



With maintaining tensile strength, succeeded introducing high degradation unit

It's confirmed that biodegradation rate improves by developed biodegradation diene rubbers

Step forwarded for highly balancing technology for toughness and degradability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