

Kreislaufwirtschaft für
den Klimaschutz

Initiativen zur CO₂-Neutralität von Kunststoffen in Japan

日本におけるプラスチックカーボンニュートラルに対する取り組み



Shigeru YAO
Fukuoka University, Japan

NEDO Representative Projects of Plastic Carbon Neutral and My Roles

Development of marine biodegradable plastics which can
control the timing and speed of their degradability

[Moonshot Research and Development Program]

← Member of the Technical Committee

Cellulose Nanofiber Related Technology Development to
Contribute to a Carbon Cycle Society

[Materials and nanotechnology Project]

← Project Leader

Innovative Plastic Resource Circulation Process Technology
Development

[3R and water circulation Project]

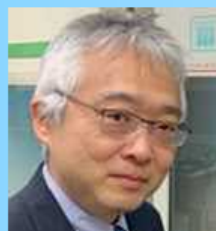
← Theme Leader

Development of marine biodegradable plastics which can control the timing and speed of their degradability



Development of Multi-Lock Biopolymers Degradable in Ocean From Non-Food Biomasses

Project Manager (PM) : ITO Kohzo, The University of Tokyo



Research and Development of Marine Biodegradable Plastics With Degradation Initiation Switch Function

Project Manager (PM) : KASUYA Ken-ichi, Gunma University



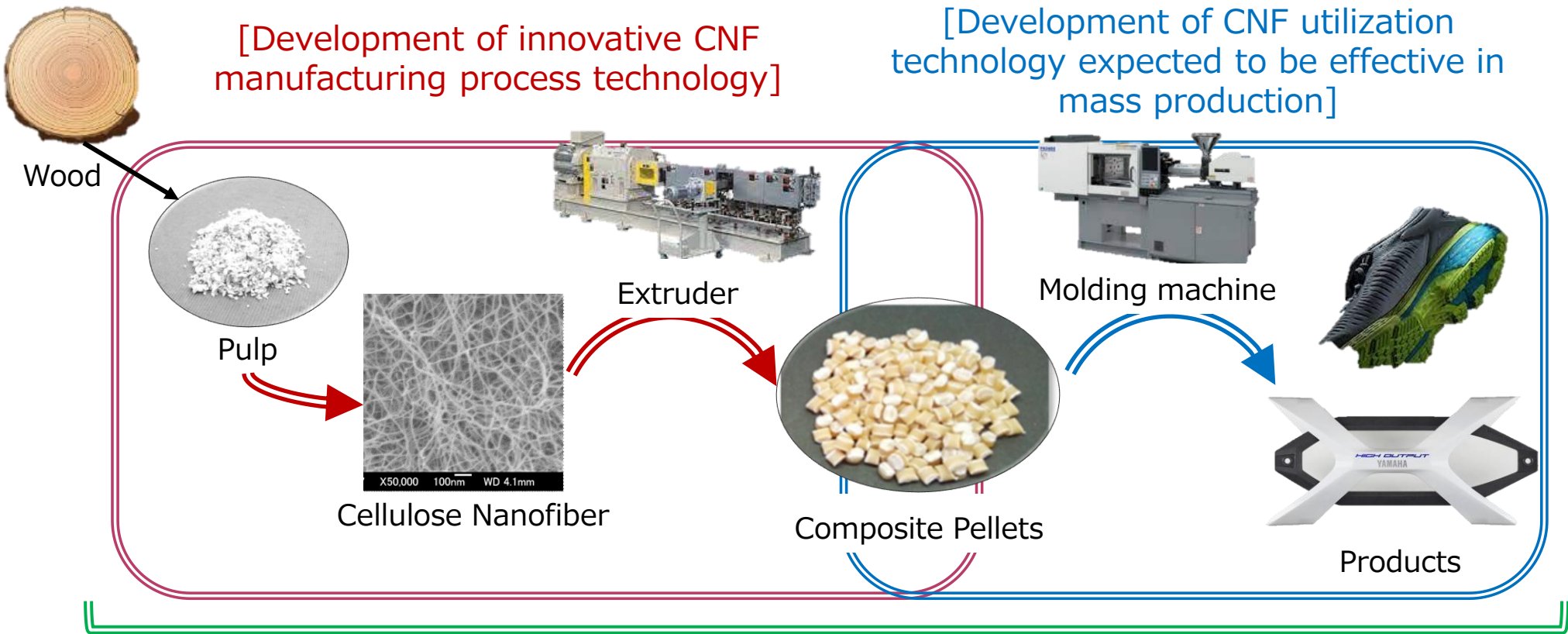
Development of Photo-Switching Ocean-Degradable Plastics With Edibility

Project Manager (PM) : NAKAYAMA Atsuyoshi,
National Institute of Advanced Industrial Science and Technology (AIST)

Cellulose Nanofiber Related Technology Development to Contribute to a Carbon Cycle Society

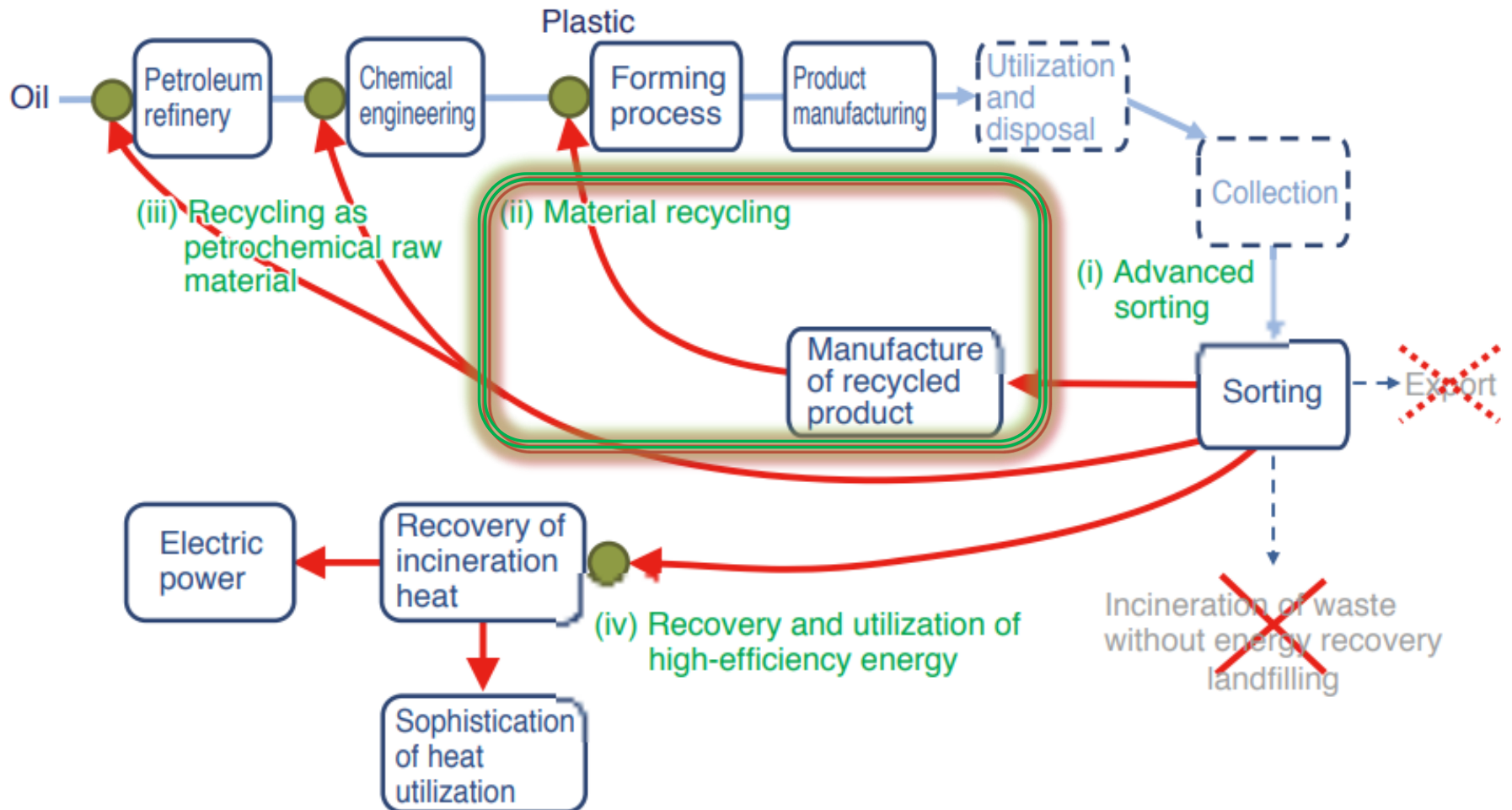
[Development of innovative CNF manufacturing process technology]

[Development of CNF utilization technology expected to be effective in mass production]



[Development of evaluation methods, etc. necessary for the dissemination of results]

Innovative Plastic Resource Circulation Process Technology Development



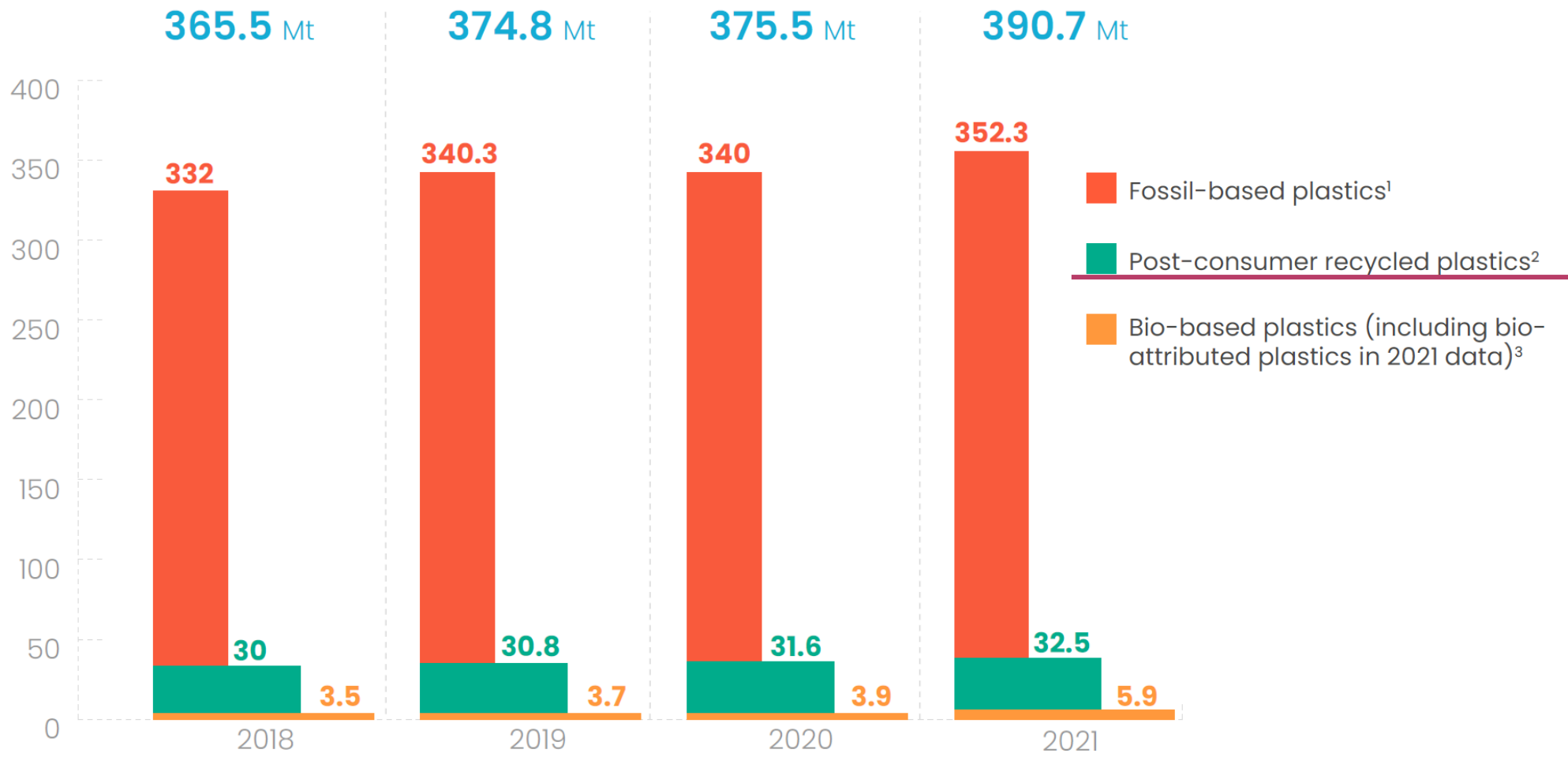
Consideration from **increasing waste plastics**



The screenshot shows the UN Environment website interface. It features the UN Environment logo, navigation menus for 'Who we are', 'What we do', 'Action Plans', 'Meetings', 'Structure', 'News', and 'Resources', and a search bar. The main content area displays a photograph of a beach heavily littered with plastic waste, with several colorful fishing boats in the foreground. A blue banner at the bottom of the image reads 'UN DECLARES WAR ON OCEAN PLASTIC'.



Recycle is very important



The amount of PCR plastics have not increased much



The reason why the mechanical recycle increase

ACS **Macro Letters**

pubs.acs.org/macroletters

Viewpoint

100th Anniversary of Macromolecular Science Viewpoint: Needs for Plastics Packaging Circularity

Stijn Billiet and Scott R. Trenor*

Cite This: *ACS Macro Lett.* 2020, 9, 1376–1390

Read Online



Insufficient mechanical properties (e.g. strength)

The colour of rPM

The smell/odour of rPM of the finished goods

The smell/odour of rPM during the production process affecting health/safety of employees

Visual aspects in finished products

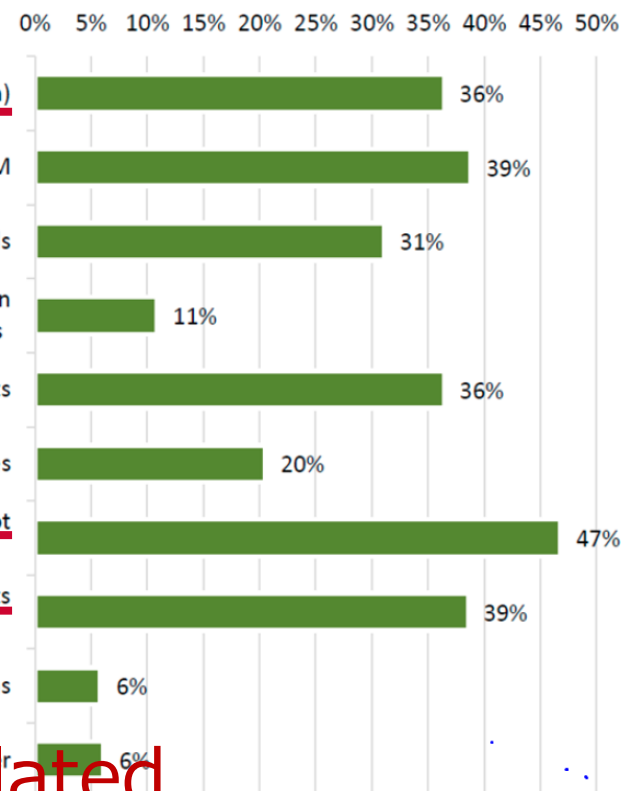
Functionalities

Insufficient reproducibility of properties from lot to lot (quality of input rPM varies too much)

Continuously tightening of quality requirements driven by market and regulation

No qualitative problems

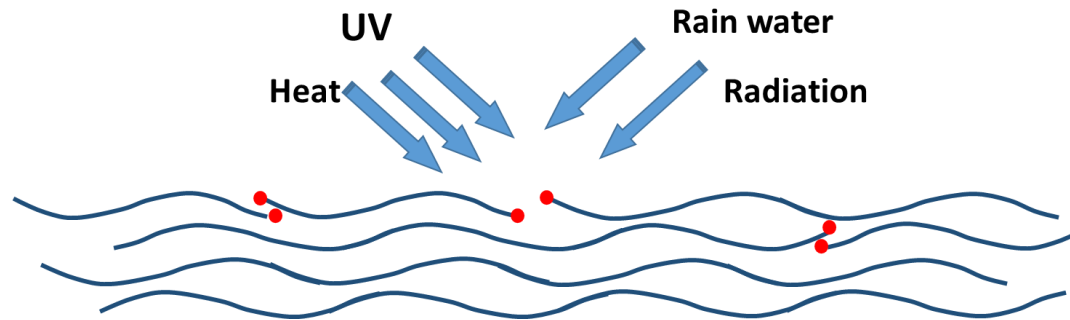
Other



It is important to solve problems related to mechanical characteristics

Why is the mechanical properties of MR plastics very poor?

The waste plastics have been chemically degraded (believing).



- Polymer chain is easily broken by chemically
- By the chemically degradation, the polymer chain was broken and become short
- Mechanical properties become poor

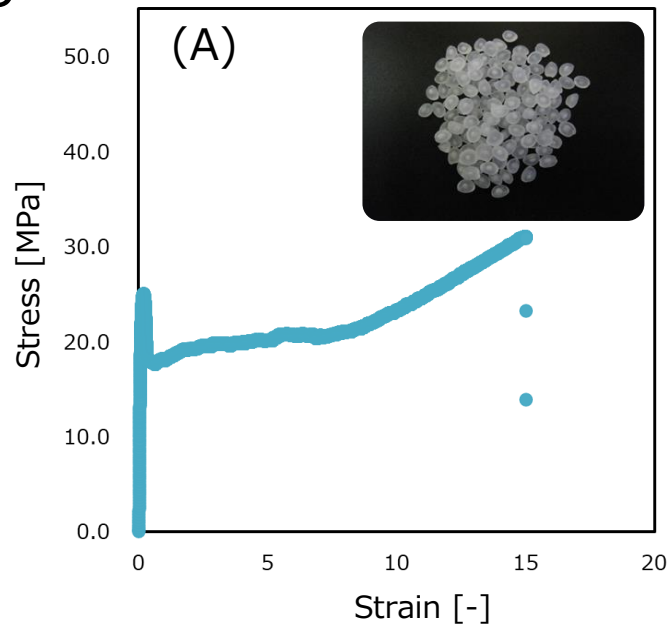
And also, the Chemical degradation can not be regenerate.

The regeneration of the mechanical properties by mechanical recycle is **Impossible.**

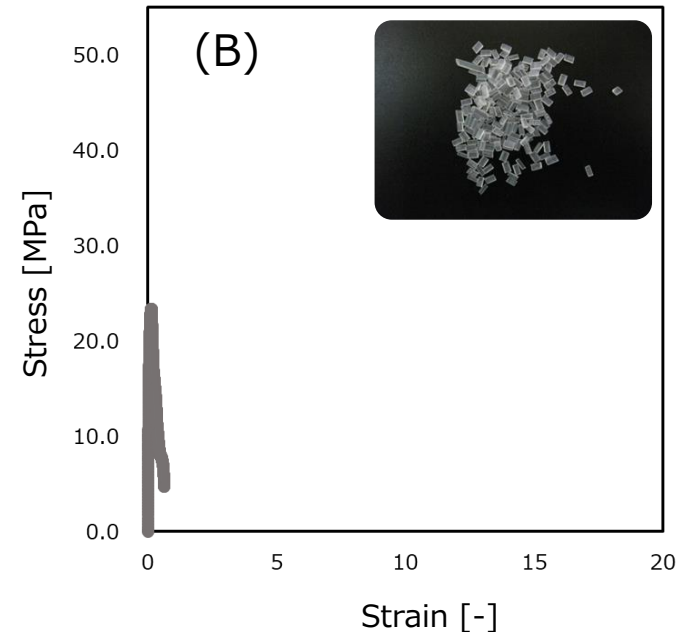
← Today's Common Sense

Comparison of Mechanical Property between Virgin Polypropylene (VPP) vs. Post Industrial recycled PP (PIR-RPP) made from by-products of the molding processes

VPP

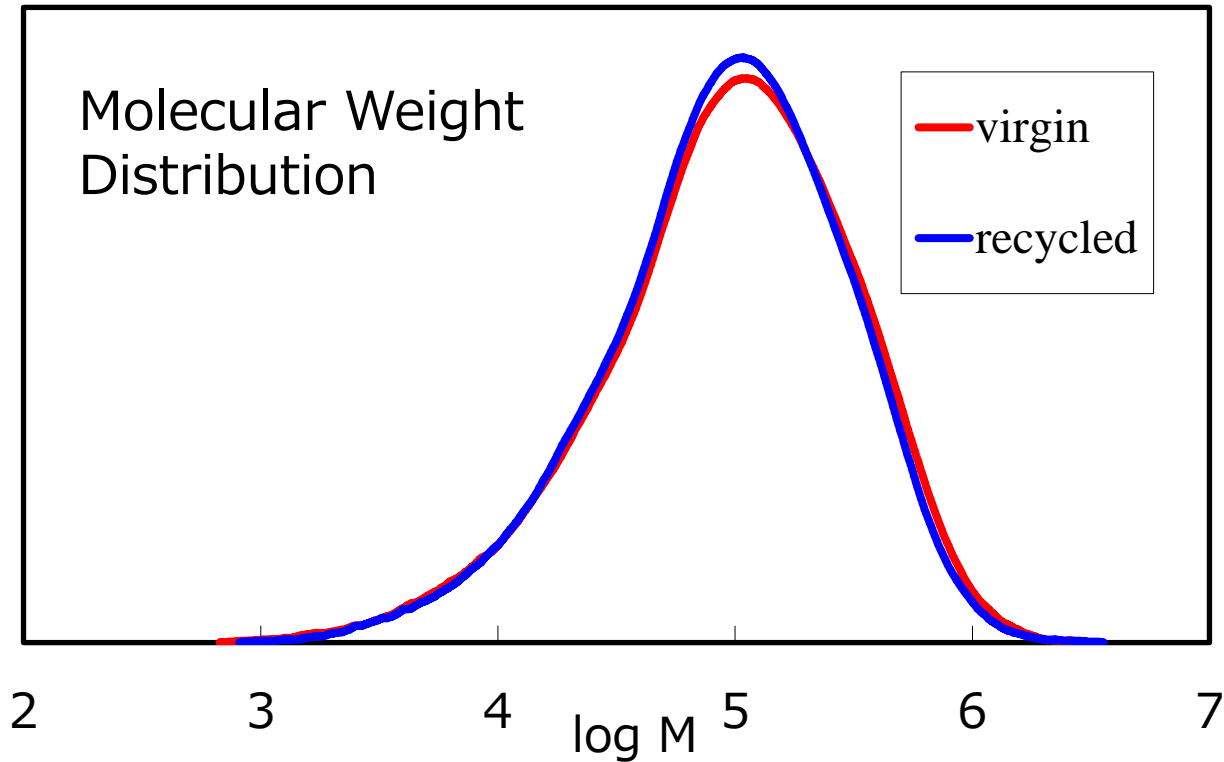


PIR-PP



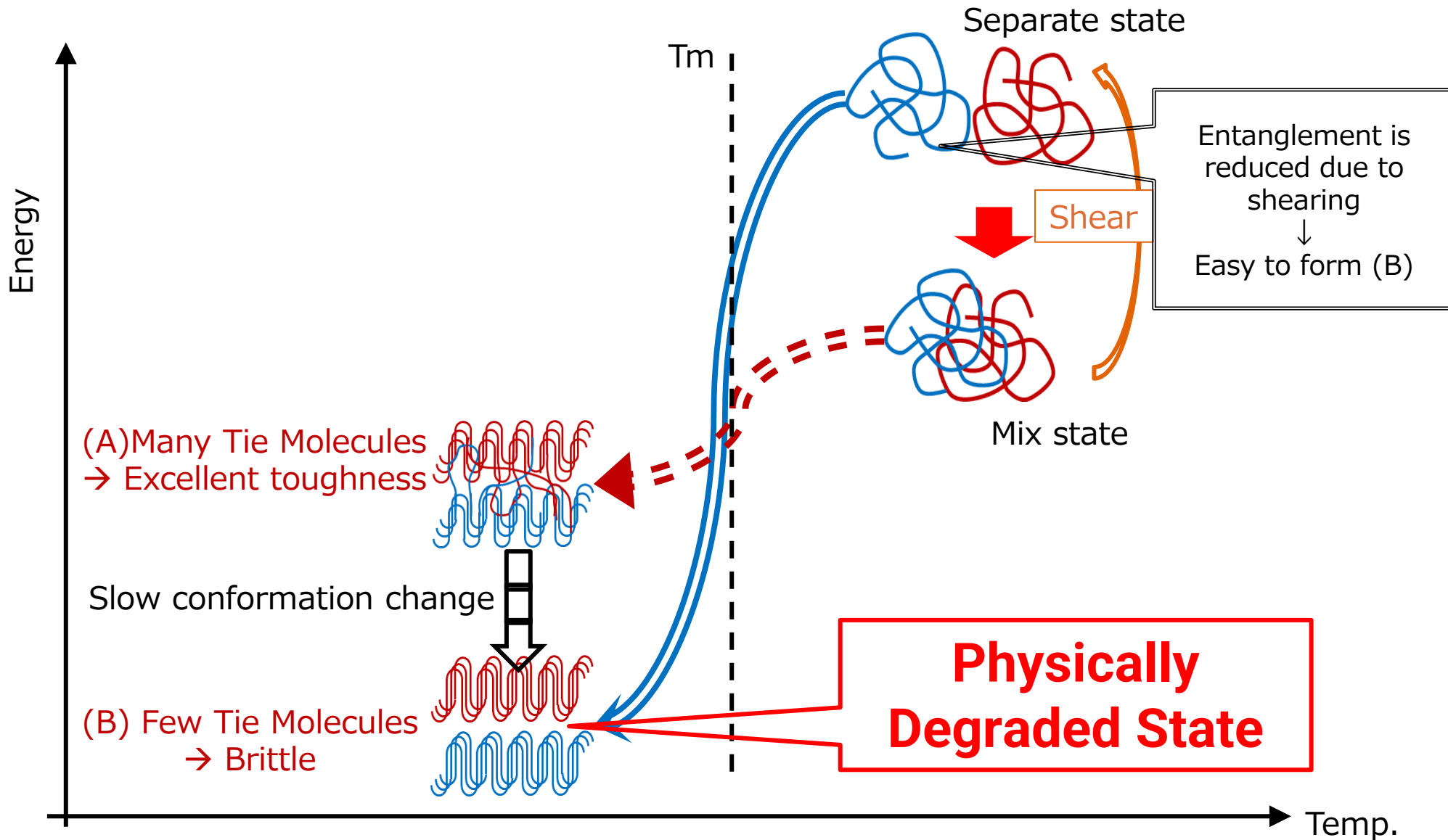
Stress-strain curves of VPP and Pre-RPP in tensile test (A):VPP, (B):Pre-RPP

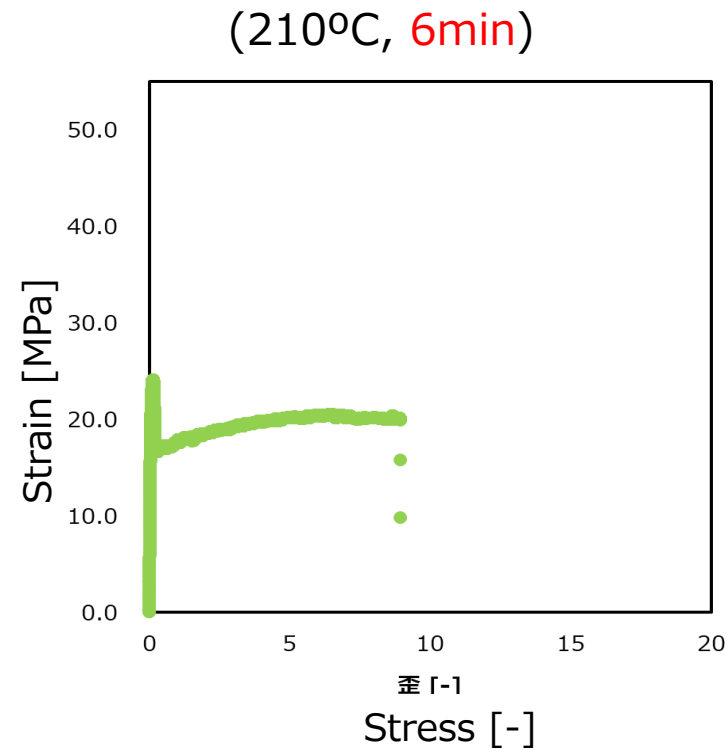
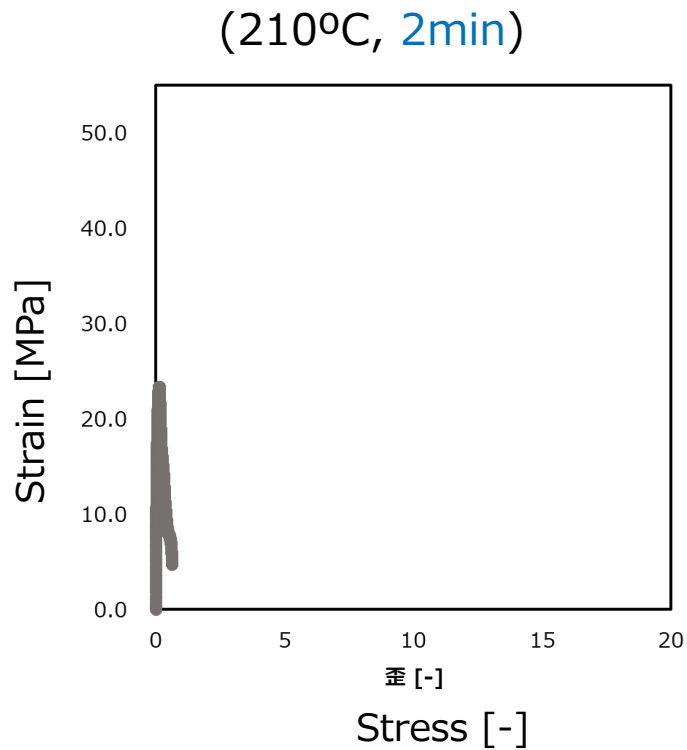
However, the molecular weight and the distribution were not **changed**



Without Chemical Degradation, Mechanical property is change.
The origin of the poor mechanical properties is Physical Degradation?

Physical Degradation & Physical Regeneration Theory





Mechanical properties can be regenerated



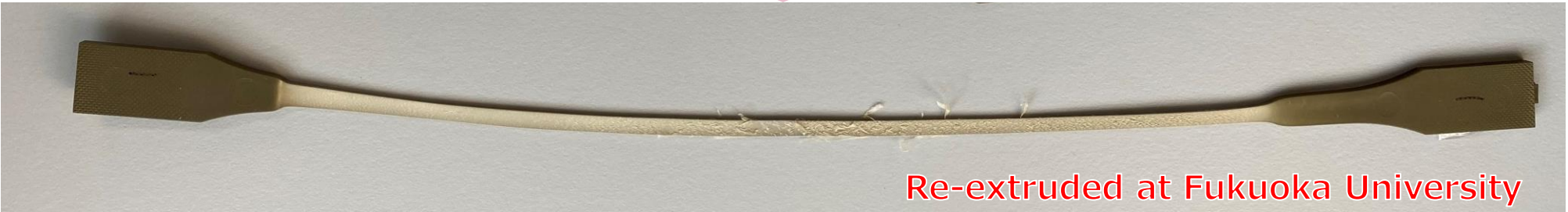
Toward Practical Research

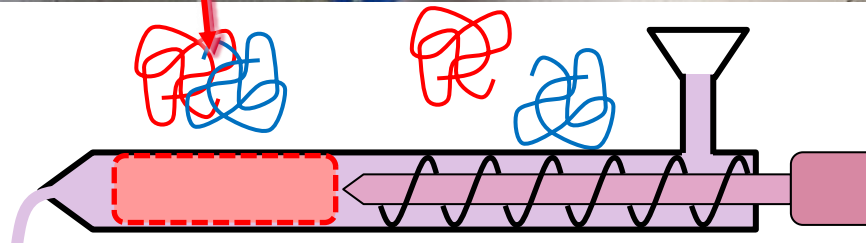


Molten Resin Reservoir
MRR



New Type Extruder designed by Fukuoka University





At the MRR

- Relax the high sheared molded history
- Strengthen the compatibility and entanglement between polymers



Achieves the advanced regeneration of recycled plastic

Recent result of Automobile Shredder Residue

Joint research with Nissan Motor Co.

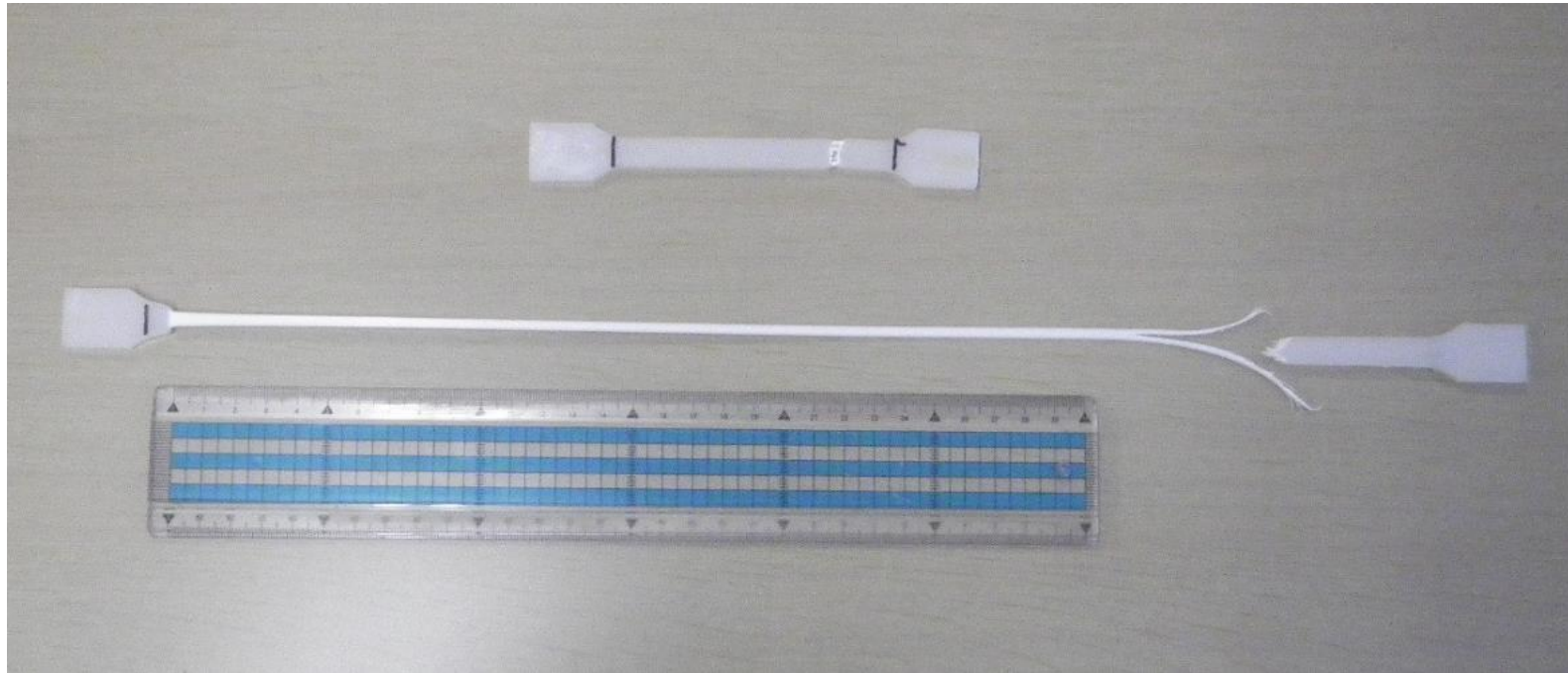


← You can see the report form here

Other company's example

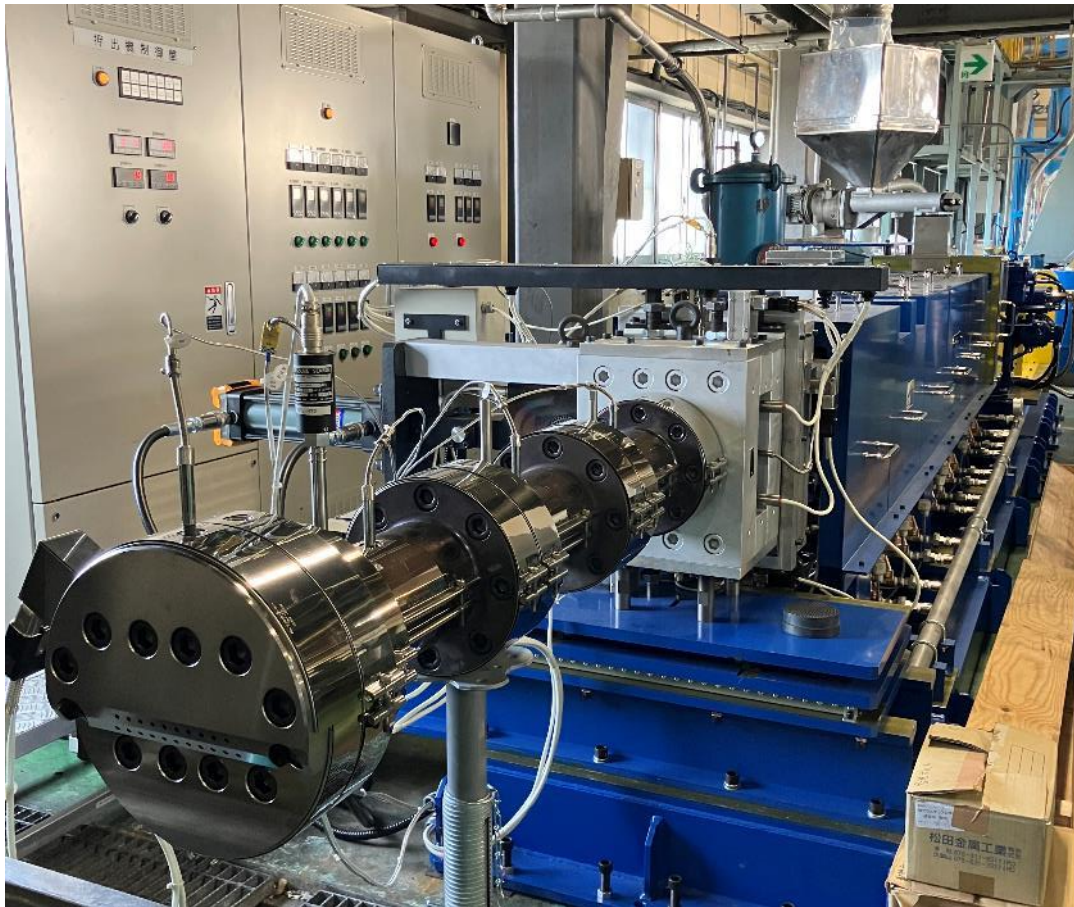
Green Science Alliance Press Release
Develops Revolutionary Plastic Recycling Technology for
Recovery of the Mechanical Strength of Plastic Waste

21 Dec 2021

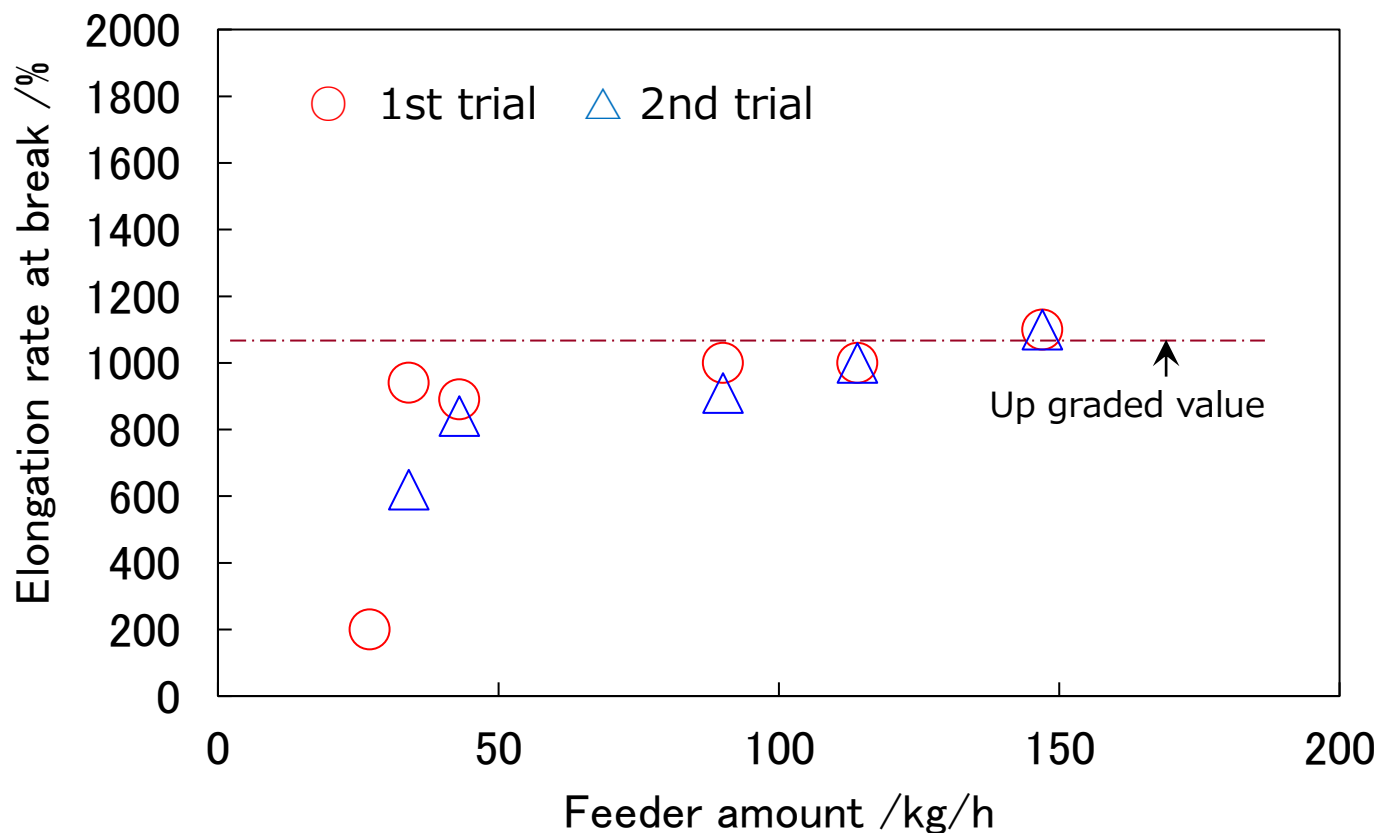


<https://www.newsweekjapan.jp/press-release/2021/12/gs.php>

Implementation of a 70mmφ high-performance extruder (300kg/h)



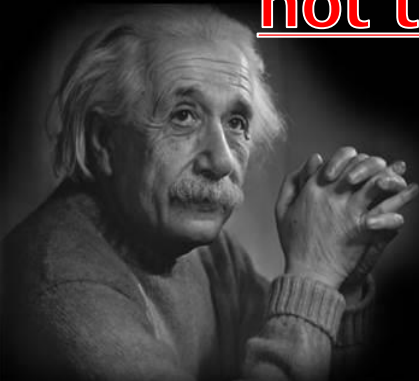
Results in scale-up experiments



Even if scaled up, advanced physical properties can be regenerated by molding in an extruder with a molten resin reservoir.

Common sense is the
collection of prejudices
acquired by age
eighteen.

Common Sense is
not the Truth



Albert Einstein
German Theoretical-Physicist
(1879-1955)

QuoteHD.com

Recycle plastics are not
Chemically Degraded,
but
Physically Degraded

Regeneration of
mechanical properties of
recycled plastics
is **Possible.**

The research style of this project

Turn this triangle firmly

Physical / mechanical characteristics

Asahi Kasei, Kao, DIC, Toppan, Mitsubishi Electric, Lion, Mobius Packaging

Regeneration utilizing the self-resilience ability of polymers



Internal / Meso scale structural analysis
(Elucidation of the generation mechanism of physical characteristics)

Molding condition • history
Relaxation and Memory
(Molecular / Theoretical Approach)

Fukuoka University, Tokyo Institute of Technology, Kobe University, Yamaguchi University, Kyoto Institute of Technology, The National Institute of Advanced Industrial Science and Technology

Fukuoka University, Kyushu Institute of Technology, University of Shiga Prefecture, Iso, Sanko Gosei, Toyama Kankyo Seibi, PLABOR Research Laboratory of Plastics Technology, S-VANCE

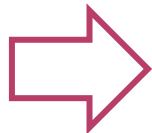
From the Physical Degradation and Physical Regeneration Theory

Recycling Area

- Advanced Physical Properties Recovery of Waste Plastics
- Molding method that minimizes degradation and variation of physical properties
- Development of high value-added products using recycled plastics

Production area

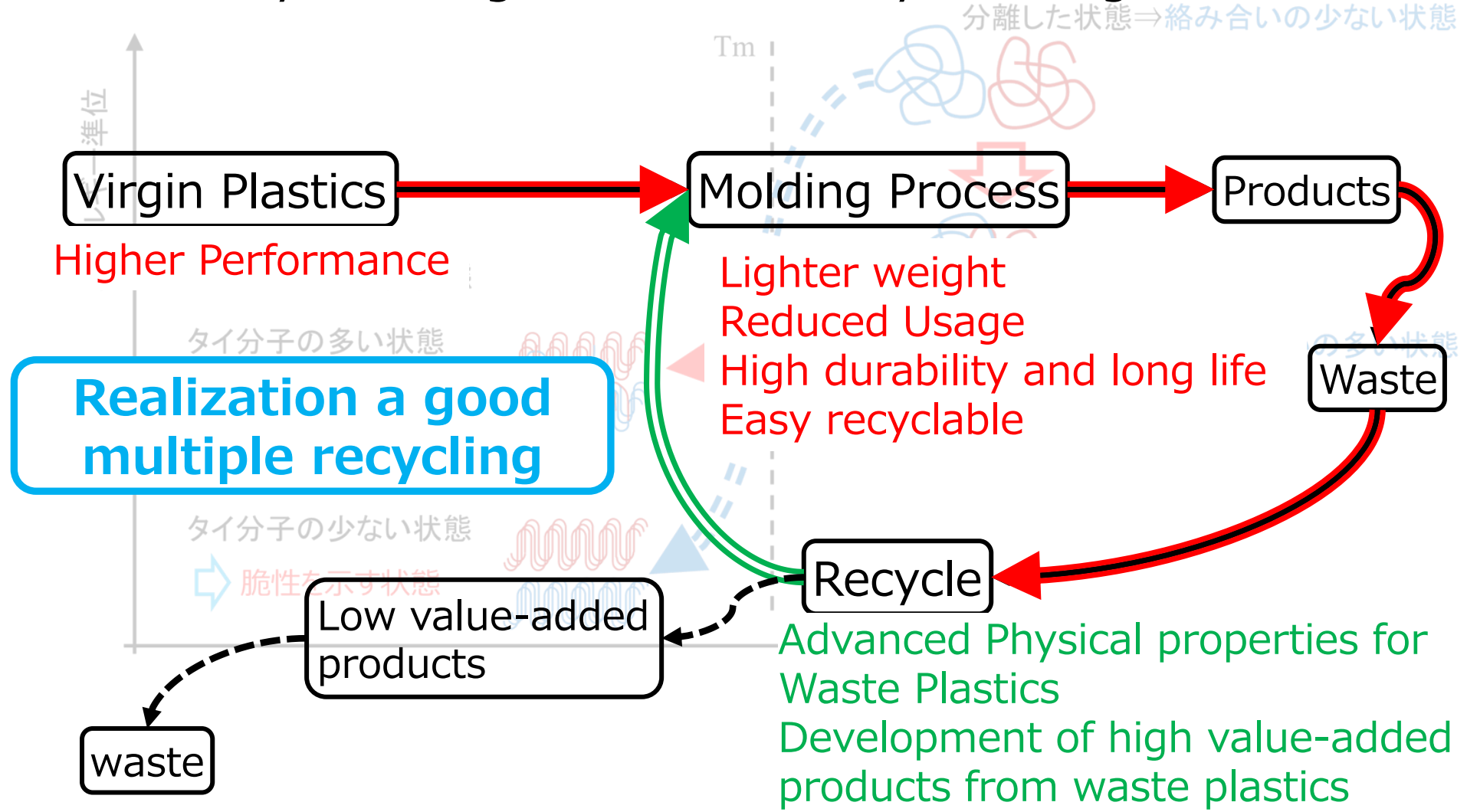
- Improvement of performance of virgin resin
 - ←High performance/light weight/reduction of usage fee
 - ←High durability and long-life molding products
- Development of easily recyclable molding process



Revolutionary Mechanical Recycle



The Innovative Resource Recycling of Plastics from the Physical Degradation and Physical Regeneration Theory



I will make a presentation at
“6th Forum Plastic Recyclates”



All interested parties are welcome to attend.



Thank you for your kind attention

Relaxation is very important
for both Plastics and Human

Then You can create a new idea



This presentation is based on results obtained from a project, JPNP20012, commissioned by the New Energy and Industrial Technology Development Organization (NEDO).