Abstract

[Research Title]

Promotion of Expanded Use of Biomass-based Plastics through Cellulose Nanofiber Reinforcement

Project Period (FY) :	2021-2023
Principal Investigator :	Yano Hiroyuki
(PI ORCID) :	ORCID0000-0001-2345-6789
Principal Institution :	Kyoto University, Kyoto, Japan, JAPAN Tel: +81-774-38-3669 Fax: +81-774-38-3655 E-mail: yano@rish.kyoto-u.ac.jp
Cooperated by :	Kyoto Municipal Institute of Industrial Technology and Culture, Sustainable Management Promotion Organization
Keywords :	Biomass-based plastics, Cellulose nanofibres, Structural applications, Carbon neutral, Biodegradable

[Abstract]

Through a collaboration of three institutions with the cooperation of 17 companies, the uses of biomass-based plastics in structural applications were examined, namely reinforcement with cellulose nanofibers (CNFs). Under sub-theme 1, the performance of CNF reinforced bioplastics (PLA, bio-PE, PBS, and PHBH) was examined in applications including: (1) high-stiffness structures, (2) impact-resistant structures, (3) soil-degradable and high-stiffness materials, and (4) marine-degradable and high-strength materials. All materials were evaluated for their environmental performance. It was found that CNF reinforcement of bio-PE can produce lightweight and heat-resistant composites with rigidity and strength equivalent to that of automotive talc-added PP resin, as well as composites with high elasticity and impact resistance. For biodegradable biomass-based plastics, it was also found that CNF reinforcement can improve strength and foaming properties without compromising marine degradability. Furthermore, in term of soil degradability, it was found for the first time that a CNF network in biodegradable biomass-based plastics promotes biodegradability from the inside of a product while maintaining its shape. The greenhouse gas emissions associated with production of each composite material were calculated, a provisional calculation methodology for conducting LCA was developed, and the greenhouse gas emissions of CNF reinforced biomass-based plastics were calculated. On the basis of these evaluation results, under sub-theme 2, CNF reinforced biomass-based plastics were provided to the 17 companies, which evaluated the processability and performance of molded products in test and production molds. As a result, 20 potential practical applications were identified, exceeding the study target of 16 items. Furthermore, the material evaluation provided by this study led Ueyama Seisakusho Co. to commercialize three stationery products composed of CNF-reinforced bio-PE in 2023. The scope of data collection required for conducting LCA on CNF composite materials was determined and the LCA for CNF reinforced bio-PE products was performed.

This research was funded by the Environment Research and Technology Development Fund (ERTDF).