Title of Research:

19_D08-01

Elucidation of the formation mechanism of microplastics

Principal Investigator:

Kuroda Shinichi (Graduate School of Science and Engineering, Gunma University)
29-1 Honmachi, Ota City, Gunma Prefecture 373-0057
(tel) 0276-50-2434 (e-mail) skuroda@gunma-u.ac .jp

Collaborators:

Kouzai Hiroaki (Department of Science and Engineering, Kanto Gakuin University)
Kuriyama Takashi (Graduate School of Organic Materials and Systems Science, Yamagata University)
Ohtani Hajime (Graduate School of Engineering, Nagoya Institute of Technology)
Igarashi Toshio (Research Division for Science and Technology, Kanazawa University)
Hiejima Yusuke (Research Division for Science and Technology, Kanazawa University)
Tokumitsu Katsuhisa (Materials Science Division, Faculty of Engineering, University of Shiga Prefecture)
Nakatani Hisayuki (Department of Chemistry and Materials Engineering, Nagasaki University)

Summary of Research:

The purpose of this study is to clarify by what mechanism and from what kind of plastic products the secondary microplastics are generated from the perspective of polymer science and polymer engineering. Various approaches of us lead the following results.

In the analysis using the pyrolysis method, individual component information was successfully extracted from the plastic mixture samples by means of Py-APGC-MS measurements with selecting the ions characteristic of the object polymer and recording the ion chromatogram with high mass resolution.

In the morphological analysis of secondary microplastics, the microplastics recovered from rivers and beaches showed cracks as in the outdoor-exposed polymers, where light-induced oxidation takes place. On the other hand, no crack was observed in the microplastics recovered from marine.

In a study considering microbial corrosion, the ”ABC degradation” mechanism was revealed: it was found that a complex degradation takes place where the hydrophilization of polymer proceeds owing to the photo-oxidative degradation (Abiotic) and microbial corrosion (Biotic), followed by the micro-flake detachment (Cutting) due to the dissociation of the hydrophilic zone caused by water ingress.

Chemiluminescence analysis shows that hydrophobic polyolefins such as HDPE and PP tends to decelerate the degradation owing to the suppression of temperature increase and oxygen diffusion due to the presence of seawater.

Focusing on mechanical effects, it is was found that fatigue may cause the fragmentation of plastic materials and that the jet mill could efficiently fine-grind plastics.

In the future, a database of literature and research results on the formation mechanism of microplastics will be build. In addition, the microplastic formation behavior through long-term outdoor exposure will be observed and the microplastic accelerated generation test methods will be developed.

Timeline:

March 1, 2019 - February 29, 2020

Topics:

Poster presentation at JCIA LRI Annual Workshop 2019 "Elucidation of the mechanism of microplastic formation" (Tokyo, August 30th, 2019)

Publications:

1. Kuroda Shinichi, "Trends in Research on Microplastics", Materiaru Raifu Gakkaishi, 31 (1): 10-14, 2019

2. Kuroda Shinichi, "Microplastics - its problems and research trends", Jisedai Poriorefin Sogokenkyu, 13: 17-22, 2019
3. Igarashi Toshiro, "Resource recycling of PE from the perspective of microplastics", Jisedai Poriorefin Sogokenkyu, 13: 23-30, 2019