Title of Research:

22-D-01 Elucidation of the mechanism and rate of microplastic formation contributing to risk assessment and preparation of standard microplastics

Principal Investigator:

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Summary of Research:

The purpose of this research is quantitative elucidation of the formation mechanism of microplastics under natural environments and development of a method for the preparation of “reference” microplastics for risk assessment. We conducted precise analyses of plastics degraded in the natural environment by outdoor exposure tests, and we found that photo-oxidation reactions induce crystallization in the weathering layer at a depth of 50-250 μm from the surface, which leads to slow crack growth inside the material owing to volume shrinkage. Kinetic analysis using artificially degraded materials by accelerated tests revealed that microplastics of about 0.2 mm in diameter are slowly formed over several years by similar mechanisms. We compared the artificially accelerated test and outdoor exposure test, which generally gave different results, we found that hydrolysis in the presence of water is important for PET. A method of analysis for airborne microplastics was also developed. Based on the microplastic formation mechanism, a method for preparing reference microplastics was developed, and the “reference” microplastics of low-density polyethylene in a size of 10, 30, and 100 μm were provided for risk assessments.

Timeline:

March 1, 2022-.

Topics:

July 14, 2023: Cite visiting at Kanazawa University
Aug 25, 2023: Oral presentation at 2023 LRI Research Report Meeting

Publications: (Only PI)

An oral presentation is scheduled in Sep. 2024; Y. Hiejima, “Formation of parallel cracks driven by chemicrystallization and subsequent fragmentation into microplastics”, 11th Conference of the Modification, Degradation, Stabilization of Polymers Society (MoDeSt2024)
To be submitted to Polymer Degradation and Stability; Y. Hiejima *et al.*, “Parallel crack formation in thermal degradation of isotactic polypropylene and subsequent spontaneous fragmentation into microplastics”