Micro-textured glass surfaces to produce microplastics for biological tests

Y. Nakanishi[1]*, Y. Nakashima[1], Y. Fujiwara[2]

[1]Faculty of Advanced Science and Technology, Kumamoto University
2-39-1 Kurokami, Chuo-ku, Kumamoto, 860-8555 JAPAN
[2] Faculty of Life Sciences, Kumamoto University
1-1-1 Honjo, Chuo-ku, Kumamoto, 860-8556 JAPAN

Keywords: Surface texturing, Microplastics, Polymer, Fatigue wear, Abrasive wear

Plastic wastes can be fragmented into smaller debris. The ubiquitous presence of microplastics (MPs) in the environment is a cause for great concern; various studies related to the MPs have been conducted. This study aimed to develop a method for producing MPs in the micrometre range for various biological tests, where the morphology and constituents of the MPs were guaranteed.

The proposed production system was a pin-on-disc machine with multi-directional sliding motions. Pin made of polyethylene (PE), polypropylene (PP), polyvinyl chloride (PVC) or polyethylene terephthalate (PET) was pressed onto a quartz glass disc under the lubrication of artificial sea water. Micro-textured glass surfaces were prepared by the combined application of a masking process and a micro slurry-jet process with the objective of generating particles with various morphologies. Ultraviolet irradiation (UV: 280-315 nm) was performed through the glass disc to the sliding surfaces during fragmentations of the polymer plastics.

Evidently, the UV promoted the fragmentation of polymer plastics. It was supposed that the UV influenced the equivalent circle diameters of MPs but did not affect the aspect ratios and complexity. Differences in the crystalline or amorphous plastic and the copolymer or condensation polymer might affect fragmentation speeds. It was confirmed that the geometry of the micro-textured glass surface could control the fatigue wear, abrasive wear, and adhesive wear of the polymers such that the morphological aspects of MPs could be controlled. It was already confirmed that the morphological aspects of MPs generated were similar to those of the MPs collected and analysed in our environments. Evidently, the quality management of microplastics is possible by adjusting the surface profiles on the quartz glass discs.

*Corresponding author: y-naka@mech.kumamoto-u.ac.jp