ABSTRACT

From macro to microplastics: Weathering and fragmentation of plastics

Won Joon Shim[1,2], Young Kyoung Song[1,2], Sang Hee Hong[1,2], Soeun Eo[1,2]
[1]Korea Institute of Ocean Science and Technology, Geoje, Republic of Korea.
[2]Korea University of Science and Technology, Deajeon, Republic of Korea

The secondary microplastic production from macroplastics by weathering such as photochemical oxidation is expected one of major input sources of microplastics in marine environments. Fragmentation process and rate of nano- and microplastic production, however, are largely unknown. Our previous study revealed that foamed plastic, such as expanded polystyrene (EPS) was highly susceptible to UV as well as mechanical weathering due to the unique foamed structure compared to polyethylene and polypropylene. In addition, foamed plastics including EPS are one of common marine plastic debris items in the ocean worldwide. In this study, we aimed to identify micro- (0.8-500 μm) and nanoparticles (2-800 nm) of EPS produced by sunlight exposure for 2 years including size distribution. The abundance of produced particles increased by increasing sunlight exposure time (micro particles: 3.4×10^6 - 6.7×10^7 particles/cm^2 and nanoparticles: 4.0×10^7 - 5.7×10^8 particles/cm^2), and the average size of fragmented EPS particles were in range of 2.03-2.88 μm for microparticles and 138-189 nm for nanoparticles, respectively. The abundance of microparticles increased by decreasing size, but nanoparticles showed bimodal size distribution based on 100 or 80 nm. The estimated fragmentation rate was 2.6×10^8 particles/year•cm^2 by sunlight exposure according to linear regression equation ($y=-16295045+55231x$, $r^2=0.94$, $p<0.01$). Any EPS litter directly exposed to sunlight in the environment can be a kind of factory for continuously producing secondary nano- and microplastics within relatively short time span. Therefore, not only reduction of plastic litter input to environments, but also efficient and rapid clean-up of residual macroplastic in environment is required to reduce huge amount of secondary microplastic generation.

Email: wjshim@kiost.ac.kr