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The degradation characters of polyvinyl chloride eroded in the natural environment

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Statement of the Problem: Organisms which ingest micro-plastics may not only experience physical harm, such as internal abrasion and blockage but are also exposed to chemical additives in plastics. These include persistent, bioaccumulating and toxic chemicals which adsorb and accumulate on plastic from the water column. Comprehending the surface change of micro-plastics eroded in the natural environment could enlarge our knowledge of the interaction of pollutant and plastic marine debris. The extent and rate of trace metal and hydrophobic organic chemical (HOCs) (de)sorption are influenced by the surface properties of sorbents, such as eroded polyvinyl chloride (PVC) in the coastal environment. These surface properties could explain the interactions among plastics, microbes and pollutants. The primary objective of this research is to understand the surface properties such as altered surface functional groups and surface topography of aged PVC pellets under heat, UV and solar in seawater.

Methodology & Theoretical Orientation: Knowledge of polymer morphology is essential for understanding the processes and mechanisms of degradation. The morphology of eroded PVC was examined using Environmental Scanning Electron Microscope (SEM), equipped with Spectrometers Energy Dispersion X-ray (EDS). FTIR was used to identify functional groups on the PVC surface after environmental erosion.

Findings: The surface of virgin PVC seems smooth and uniform, but the eroded one is rough and uneven from electron photomicrographs of the surface topography. Thermal degradation of PVC increases peaks at 1595 cm^{-1} which implies the formation of C=C and 1735 cm^{-1} as ester carbonyl bonds (–COO–). On the other hand, UV degradation of PVC increases peaks at 1735 cm^{-1} which is ester carbonyl (–COO–) and 2500-3500 cm^{-1} which is carboxylic acid (–COOH). However, the FTIR spectra for eroded PVC via solar with seawater is similar to the virgin one.

Conclusion & Significance: Thermal and UV degradation presented different PVC morphologies such as surface area, pore size, pore volume and pattern. In addition, the increased functional group went through a dehydrochlorination mechanism during the aging process and transformed the chemical properties of PVC. Whether the PVC eroded by solar in seawater or not, this uneven surface seems to originate from the skin of virgin PVC degraded but no new functional group was found. It suggests that chemical properties of PVC seem durable for a long time in the environment.

Biography

Chih-Cheng Tang, Doctor Candidate, Department of Marine Environment and Engineering, National Sun Yat-sen University, Taiwan, Republic of China. Chih-Cheng Tang is a Doctor Candidate and follows Professor Chon-Lin Lee, Professor Huey-Ing Chen, and Professor Peter Brimblecombe who have their specialty in identification and transmission of persistent organic pollutants in the environment. The research team announced plastic debris encountered degradation during floating in the ocean altered the surface properties such as functional groups, surface topography and color transformed, and the adsorption behavior of marine litter for HOPs and heavy metals that are different from virgin one. In this study, PVC was aged for seven month with UV, oven, artificial seawater in laboratory and solar in the environment under control. Results reveal aging of PVC degraded by light or heat; the mechanisms of degradation follows a dehydrochlorination reaction and engender polyene chains and new functional groups. The outcome contributes to understanding the interactions among plastics, microbes, and pollutants.

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