Role of Particle Size and Surface Wettability in the Mineralization of Decorative Polystyrene Microplastics with Calcium Carbonate

Aleksandra Szcześ [a] , *Wiktoria Kamień* [a]

[a] *Department of Interfacial Phenomena, Institute of Chemical Sciences, Faculty of Chemistry, Maria Curie-Skłodowska University, Lublin, Poland*

aleksandra.szczes@mail.umcs.pl

Decorative polystyrene (PS) microplastics, widely used as additives in paints, are increasingly recognized as a source of environmental contamination, as they can readily enter aquatic and terrestrial ecosystems during use and degradation. Due to their small size and persistence, these particles are easily transported and ingested by living organisms, raising concerns about their accumulation and potential ecological impact. In natural systems, mineralization processes, particularly calcium carbonate ($CaCO_3$) formation, are often associated with living organisms, where they play a fundamental role in biomineralization (e.g., shell and skeleton formation). However, similar processes may also occur on abiotic substrates such as microplastics, altering their surface properties, environmental behavior, and interactions with biota.

This study investigates the mineralization of decorative PS microplastic particles with sizes of 0.07 mm, 0.1 mm, and 0.4 mm. The main objective was to evaluate the influence of particle size and surface wettability on the efficiency of calcium carbonate formation. Mineralization was carried out using two approaches: CO_2 diffusion and direct precipitation from calcium chloride and sodium carbonate solutions at concentrations of 0.05 M, enabling controlled $CaCO_3$ deposition on hydrophobic polymer surfaces. To enhance surface wettability, an anionic surfactant, sodium dodecyl sulfate (SDS), commonly found in cosmetic and household products was applied.

The results demonstrate that calcium carbonate effectively nucleates and grows on the surface of microplastic particles, with preferential deposition at high energy sites such as edges and surface irregularities. Improved wettability leads to more uniform and extensive mineral coverage. A clear particle size effect was observed.

These findings confirm that controlled mineralization of decorative microplastics can be achieved through appropriate surface and chemical conditions, providing insight into their transformation in the environment and suggesting a potential pathway to limit their mobility and impact in ecosystems.