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Characterization of microplastics using LA-ICP-MS and LIBS

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Due to the growing demand and use of plastics, the disposal and waste of plastic products are getting more important. Even though recycling has gained more and more attention lately, a significant amount of discarded plastic still ends up in the environment. There it undergoes mechanical and chemical alteration and degradation, resulting in microplastics (MPs) formation. These MPs are suspected of releasing contained additives and adsorb trace elements from the environment. Additionally, the particles get overgrown by microorganisms, ingested by biota, and further enter the human food chain. Due to their immense impact on our ecosystems, a better understanding of their fate in the environment and characterization of their changing properties is becoming of significant interest.

In the last few years, the use of SP-ICP-MS for the assessment of particle size of MPs has become very popular. However, the characterization of MPs using solid sampling techniques is less frequently reported.

Therefore, this work investigates MPs of a wide range of commonly used polymers (e.g., PE, PET, PP, PS, PA). Different types of aging procedures were carried out, including exposure to UV radiation and oxidizing reagents followed by soaking in artificial seawater spiked with various heavy metals. Additionally, biological aging was carried out by exposing MPs to freshwater and wastewater, leading to biofilm formation.

LA-ICP-MS and LIBS were used to characterize individual particles and the surrounding biofilm. Therefore, both high-resolution mappings of cross sections and depth profiles were recorded. Here, LA-ICP-MS was used to measure the inorganic constituents of interest, revealing the uptake from the environment (e.g., Pb) in surface-near regions of the particles and the release of additives (e.g., Zn from the bulk of the particles. Additionally, the composition of the formed biofilm was assessed. To confirm the findings, microwave-assisted digestion followed by liquid ICP-MS analysis was carried out. On the other hand, LIBS is used to detect polymer-specific signals (C, H, O, C2, CN) to assess the potential degradation of the polymer particles.

LA-ICP-MS, LIBS, Microplastics, Imaging, Depth profiling