Portable spectroscopy for qualitative and quantitative analysis of microplastics

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Abstract

Plastic pollution is globally recognized as an environmental challenge for ecosystems and human health. Most plastic waste flows from land to oceans, strongly impacting marine life and organisms. More recently, small fragments at the microscale originating from the breakdown process of bigger pieces of plastic litter have become of increasing concern, driving the research efforts toward the understanding of sources, distribution, fate, and impact of these particles [1]. Microplastics (MPs) are defined as any water-insoluble solid plastic particle with the longest dimension in the range of 1μm through 1000 μm [2]. Even though the presence of MPs in marine environments is well reported [3], a legitimate and authentic analytical technique to sample, analyze, and quantify MPs is still in progress. Among the characterization techniques largely adopted in the field of polymers, vibrational spectroscopic techniques are the most commonly used for the identification and characterization in both near and middle infrared ranges, together with Raman spectroscopy. Over the past decade, the miniaturized spectrometers have gained popularity as they allow real-time assessment with no or minimal sample pre-treatment. Although there has been some research carried out on the use of micro spectrometers for the study of polymers, systematic studies are required. Indeed, there is an urgent need of harmonized and shared protocols to guarantee the capabilities of these miniaturized instruments to routinely analyze MPs. In this contribution a study of microplastics through the preparation of more realistic reference materials, named here "true-to-life" materials, will be presented. True-to-life MPs generated by mechanical fragmentation of daily used plastic items were used to develop a novel approach for direct microplastics quantification, based on a handheld portable near-infrared spectrometer coupled with chemometrics. The results are of immediate importance for data standardization to build reliable databases and to perform quantitative analysis, but are indeed poised to impact also for a fast, reliable, and in-situ environmental microplastics quantification.

References

1. GESAMP (2016) "Sources, fate and effects of microplastics in the marine environment: part two of a global assessment" (Kershaw, P.J., and Rochman, C.M., eds). (IMO/FAO/UNESCO-IOC/UNIDO/WMO/ IAEA/UN/UNEP/UNDP Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection). Rep. Stud. GESAMP No. 93, 220 p.
2. ISO - ISO/TR 21960:2020 - Plastics — Environmental aspects — State of knowledge and methodologies https://www.iso.org/standard/72300.html (accessed Apr 27, 2021).
3. Barboza, L. G. A.; Gimenez, B. C. G. Microplastics in the Marine Environment: Current Trends and Future Perspectives. *Marine Pollution Bulletin*. 2015, 97, 5–12.

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