World Academy of Science, Engineering and Technology
International Journal of Environmental and Ecological Engineering
Vol:16, No:09, 2022

Using MALDI-TOF MS to Detect Environmental Microplastics (Polyethylene, Polyethylene Terephthalate, and Polystyrene) within a Simulated Tissue Sample

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Abstract : Microplastic pollution is an urgent global threat to our planet and human health. Microplastic particles have been detected within our food, water, and atmosphere, and found within the human stool, placenta, and lung tissue. However, most spectrometric microplastic detection methods require chemical digestion which can alter or destroy microplastic particles and makes it impossible to acquire information about their in-situ distribution. MALDI TOF MS (Matrix-assisted laser desorption ionization-time of flight mass spectrometry) is an analytical method using a soft ionization technique that can be used for polymer analysis. This method provides a valuable opportunity to both acquire information regarding the in-situ distribution of microplastics and also minimizes the destructive element of chemical digestion. In addition, MALDI TOF MS allows for expanded analysis of the microplastics including detection of specific additives that may be present within them. MALDI TOF MS is particularly sensitive to sample preparation and has not yet been used to analyze environmental microplastics within their specific location (e.g., biological tissues, sediment, water). In this study, microplastics were created using polyethylene gloves, polystyrene micro-foam, and polyethylene terephthalate cable sleeving. Plastics were frozen using liquid nitrogen and ground to obtain small fragments. An artificial tissue was created using a cellulose sponge as scaffolding coated with a MaxGel Extracellular Matrix to simulate human lung tissue. Optimal preparation techniques (e.g., matrix, cationization reagent, solvent, mixing ratio, laser intensity) were first established for each specific polymer type. The artificial tissue sample was subsequently spiked with microplastics, and specific polymers were detected using MALDI-TOF-MS. This study presents a novel method for the detection of environmental polyethylene, polyethylene terephthalate, and polystyrene microplastics within a complex sample. Results of this study provide an effective method that can be used in future microplastics research and can aid in determining the potential threats to environmental and human health that they pose.

Keywords : environmental plastic pollution, MALDI-TOF MS, microplastics, polymer identification
Conference Title : ICMPP 2022 : International Conference on Microplastics and Plastic Pollution
Conference Location : Vancouver, Canada
Conference Dates : September 22-23, 2022