Imperial College London

Natural Environment Research Council

2021_57: Constructing a microfluidic chip for removing micro and nanoplastic pollution from water

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Microplastics are a ubiquitous pollutant that can enter natural ecosystems; there is estimated to be around 230,000 metric tonnes of it in our oceans and traces are beginning to be found in drinking water, food and human tissues. An important detail that illustrates the scale of the problem is that microplastics are known to exist in fragment sizes that span several orders of magnitude; ranging from millimetre-sized pieces, down to nanometre-scale fibres. Although larger pieces can be detected and removed relatively easily, the difficulty becomes greater as the fragments become smaller than 0.1 mm. This presents a technical challenge that needs to be overcome in order to effectively study microplastic pollution and remove it entirely from the food chain. This project will attempt to address this challenge by developing a new microfluidic system that can extract and quantify micro/nano plastics from water using dielectrophoresis (DEP).

DEP is an a/c electrokinetic effect that induces motion on a dielectric particle in the presence of a non-uniform electric field. +DEP occurs when the particle is more polarisable than the medium, resulting in net movement toward high-field regions on the microelectrode array, while -DEP is the inverse. The technique is typically performed using glass chips containing microelectrodes, or as part of as a flow-through system using microfluidics, where microparticles such as biological cells or nanoparticles such as biopolymers can be manipulated on-demand.

The aim of this project is to adapt this technique to extract micro/nanoplastics from water and incorporate this technology into a microfluidic device using a rapid fabrication process developed in-house. The DEP response profile for different sized micro/nanoplastics will be studied and the potential for scale-up explored, both in terms of treating large volumes of water and to test different water samples for micro/nanoplastic contamination. The ability to achieve the former could contribute to the total eradication of the issue, while the latter could eventually lead to the development of a standardised hand-held instrument for quantifying micro/nanoplastic pollution from a range of different samples, which could have a profound influence on the ability to study the true impact of the problem.