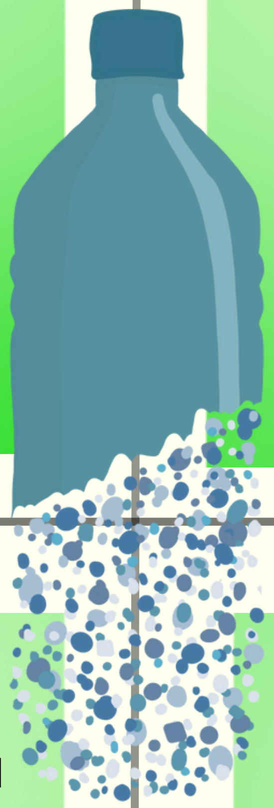
Title: Acoustophoretic Separation and Electrochemical Impedance Spectroscopic Detection of Microplastics

Members: John Goebel, Jonathan Good, Christopher Sharkey, Meghana Manjunath, Mohammed Abdul Rahman

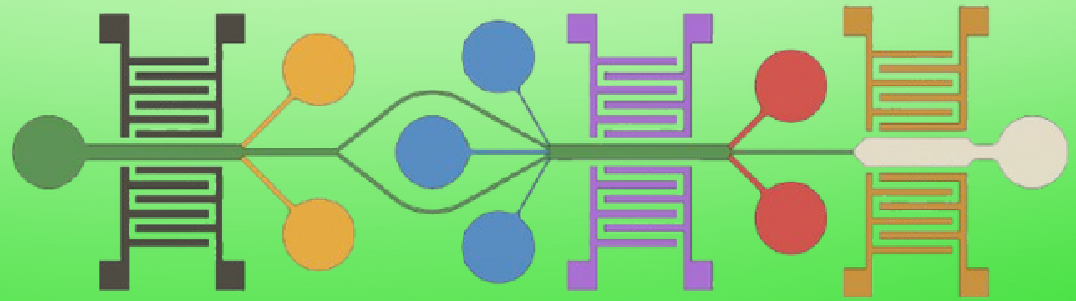
CONCEPT

We propose a solid-state, label-free sensor that combines acoustic sorting, impedance-based detection, and machine learning to differentiate PET particles from oil contaminants. This method employs acoustophoresis, a microfluidic process which uses lateral standing waves to apply forces on particles based on size, density, and compressibility. This method allows a non-contact continual sample sensors with without advanced laboratory machinery.



APPROACH

Our sensor integrates a three-stage microfluidic chip that both separates and quantifies PET microplastics in water containing crude oil. In Stage 1, black PZT interdigital transducers (IDTs) launch surface-acoustic standing waves that steer crude-oil droplets into yellow outlet channels. Stage 2 employs blue de-ionized-water side ports to sustain continuous flow with purple IDTs to deflect nanoplastics into red reservoirs, allowing PET particles larger than 1 μm to remain in the main stream. Stage 3 routes this PET-enriched microplastic flow into a tan chamber fitted with rGO-coated gold interdigitated electrodes; the resulting impedance shifts are analysed with a support-vector machine to report PET microplastic concentration.



IMPACT

This sensor enables direct, on-site monitoring of PET in crude-oil contaminated bottled water. It offers a scalable, cost-effective solution to trace microplastic origin in manufacturing, minimize public health risks, and push industry toward preventive water quality control. Our microscopic free identification could enable quick testing of MNP contamination and overall water quality to determine if more advanced filtration is needed.

CONTEXT

Plastics are inevitable in modern life, with half of all polymers ever produced manufactured in just the last 15 years. As larger plastics fragment, they generate micro- and nanoplastics that persist in the environment. Bottled-water studies reveal up to 240k nanoparticles/L, mainly PET. Additionally, bottle-plant machinery can add crude-oil contaminants to water. Current separation methods for MNPs and oil droplets often use passive consumable filters for sorting of particles by size. Particle identification then relies on spectral imaging to classify polymers, but these label-free techniques remain low-throughput and unsuitable for real-time process monitoring of complex mixtures.