Development of Terahertz Sensors for Microplastic Detection in Aqueous Samples

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Abstract
Microplastics in aquatic systems pose a significant threat to marine ecosystems and the sustainability of the Blue Economy. This project aims to develop innovative Terahertz (THz) fiber sensors for detecting and characterizing microplastics in deionized water and saltwater. Towards the goal of advancing the precision and efficiency of current environmental monitoring tools, the characterization of different microplastic polymers in aqueous samples and the development of THz negative curvature fiber sensors are proposed. The outcomes will offer a unique alternative to the current detection methods of microplastics, supporting environmental health and resource sustainability crucial to the Blue Economy.

Project Objectives

1. Characterization of microplastics in aqueous samples: In this initial step, the THz absorption spectra of different microplastics polymers such as PET, PE and PP will be measured in deionized water and saltwater solutions using our THz time-domain spectroscopy (THz-TDS) set-up. This characterization will enable the assessment of the chemical footprints in the THz region; thus, the proposed sensor parameters will be adjusted such that the footprints can be within the operational regime.

2. Development of THz negative curvature fiber sensors: Based on the spectral locations of the chemical footprints of the microplastic polymers, the design parameters of our fiber sensors will be adjusted, the electromagnetic simulations of the new geometrical designs will be performed, and the sensors will be 3d printed using a UV-resin based SLA printer. Then, the developed sensors will be characterized using the THz-TDS system without the aqueous samples filled to confirm the simulated operation.

3. Testing of the sensor performance: In this step, the sensors will be filled with the aqueous samples prepared with different concentrations of microplastics solved in deionized water and saltwater, and the sensitivity and detection limits of the fiber-based THz sensors will be calculated based on the transmission and absorption spectra obtained. The project directly aligns with the RII-NEST's commitment to environmental sustainability and resource conservation. By advancing tools for detecting microplastics, the goal is to support the preservation of marine ecosystems and the health of fisheries and aquaculture industries. Additionally, the project fosters innovation in environmental sensing technologies, contributing to the sustainable development of coastal and oceanic resources.