Photoacoustic sensor for microplastics identification in marine environments

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Seeking the ORIGINS of Microplastics

Nowadays almost every terrestrial ecosystem has some degree of plastic pollution from the artic glaciers to the agricultural fields. But where do microplastics come from?

PRIMARY MICROPLASTICS

Primary microplastics are released into the environment through various sources, including clothing fibers, beauty and cleaning products, as well as tire wear marks, which are the main contributors.

SECUNDARY MICROPLASTICS

Secondary microplastics are the result of the deterioration of macroplastics into smaller pieces due to the mechanical force of waves, UV light, temperature, and biofouling.

Identifying the origin of microplastics can aid in effectively eliminating the issue. By pinpointing the sources, we can develop targeted strategies and preventive measures to stop the introduction of these harmful particles into the environment.

DINNER IS SERVED! TODAY'S SPECIAL: MICROPLASTICS

Every meal we consume that comes into contact with plastic containers, comprises some level of contamination. Even the meat we consume is affected, as the plastic used in the animals' feeding rations leaves traces behind.

These findings raise concerns about the **safety** and **purity** of the food we consume daily, urging us to reconsider our reliance on this pervasive issue.

Sensing in the HEAT of the moment

Most technologies prioritize the extraction of a sample from the site, which is subsequently analyzed in a laboratory setting.

This approach introduces inaccuracies and contamination. Real-time analysis, on the other hand, enables more precise data collection.

CHALLENGES

Most common technology used for microplastic identification focus on **optical methods** such as Hyperspectral Image, Raman and FTIR.

Although there are several equipment's able to perform microplastic analysis, most of them are:

- **Bulk**
- **Expensive**
- **Complex to operate**

Water and organic matter poses a great challenge when it come to optical absorption methods on the NIR range.

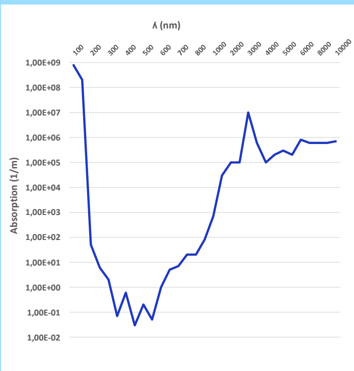


Figure 1. Absorption spectra of water.

Like chemical analysis, photoacoustic technology identifies a distinct fingerprint characteristic of a material without water interference.

Spilling the Beans on our Tech

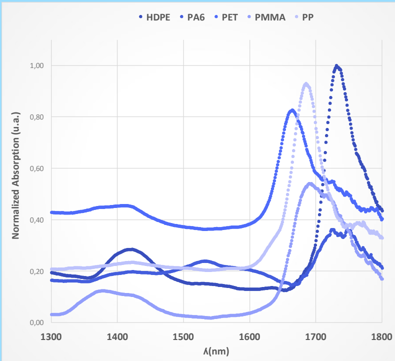


Figure 12 Absorption spectra of diferente polymers.

Raw pellets of HDPE (High-density polyethylene), PET (Polyethylene terephthalate), PP (Polypropylene) and PA6 (Nylon 6) were subjected to heating in order to create thin film samples.

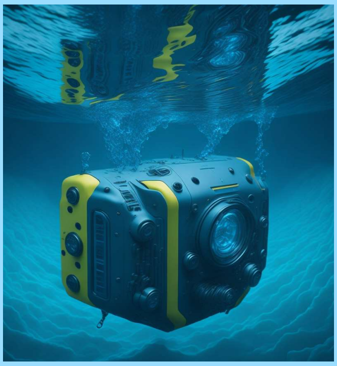
Subsequently, these samples were tested using a spectrophotometer to analyze their absorption peaks. Four wavelengths (1450, 1550, 1650, and 1720 nm) were selected, considering the most significant peaks among the plastics.

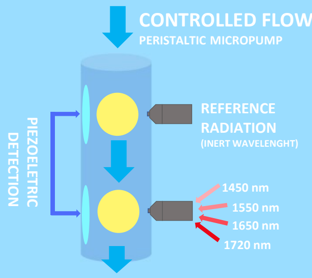
Ratios were established among several peaks to facilitate the selection of the most pertinent wavelengths for identification. An intelligent system, developed through the analysis of multiple spectra, enables the accurate identification of the sample, leveraging a robust data-driven approach.

The sensor utilizes a frequency domain detection approach employing sinusoidally modulated radiation and a lock-in system. This intelligent design reduces costs by utilizing LEDs and filters, where the generated wave has the same frequency as the excitation light.

The sensor is designed with a tiny passage (PDMS microchannel) which allows only one microplastic to pass through at a time. Along this channel, there is an infrared absorption analysis system strategically positioned.

In this setup, infrared (IR) radiation is directed through the microchannel and onto the microplastic. As the plastic absorbs the IR radiation, it converts it into heat, creating a thermal wave in the surrounding medium. To analyze this phenomenon, the control system manipulates the IR radiation by modulating and amplifying it. Then demodulates the resulting acoustic signal. This allows for precise data analysis of the absorption bands.





With this information we are now implementing the hardware and software to initiate laboratory tests.

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