Detection and identification of microplastics directly in water by hyperspectral imaging

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Abstract. Microplastics (MP) are plastic particles of size ranging from 1 µm to 5 mm. They originate from various sources such as industrial use (primary MPs) or from erosion by sand, sun, wind, waves, and mixed them in water. Using database information and spectra characteristic of the plastics, we use hyperspectral imaging (HSI) to identify the plastic types constituting mixtures of microplastics. We recently proposed to investigate microplastics directly in water. For the current study, we used a hyperspectral imaging microscope to image microplastics and mixed them in water. Using database information and spectra extracted from pristine plastic, we created a decision table allowing the identification of the type of plastic. This decision table was then mixed with water and imaged using a hyperspectral imaging microscope. The images taken were analyzed using a decision table enabling the identification. We used hyperspectral imaging to image microplastics directly in water, allowing to capture in a single measurement a spectrum of each type of plastic. The images taken were analyzed using a decision table enabling the identification. We used hyperspectral imaging to image microplastics directly in water, allowing to capture in a single measurement a spectrum of each type of plastic. The images taken were analyzed using a decision table enabling the identification. We used hyperspectral imaging to image microplastics directly in water, allowing to capture in a single measurement a spectrum of each type of plastic. The images taken were analyzed using a decision table enabling the identification. We used hyperspectral imaging to image microplastics directly in water, allowing to capture in a single measurement a spectrum of each type of plastic. The images taken were analyzed using a decision table enabling the identification. We used hyperspectral imaging to image microplastics directly in water, allowing to capture in a single measurement a spectrum of each type of plastic. The images taken were analyzed using a decision table enabling the identification. We used hyperspectral imaging to image microplastics directly in water, allowing to capture in a single measurement a spectrum of each type of plastic. The images taken were analyzed using a decision table enabling the identification.

1 Introduction

2 Experimental procedure

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3 Results and discussion

Figure 1 shows the spectra and the normalized spectra of the different MP types in water. They have been extracted from images and normalized with that of water.

**Fig. 1.** Comparison of the reflectance factor in the range 920–2530 nm of 10 MPs in water (black curves) and the reflectance spectra after subtraction of water and normalization with 1550 nm intensity (colored curves).

By carefully choosing the principal spectral features, e.g., a peak, a dip, or a gradient, and comparing with the spectra obtained with standard spectrometer on pristine plastics and other database, we can draw a logic table enabling the determination and identification of the plastic type, pixel per pixel. It is to be noted that using the first derivative of the curves presented in Fig. 1 allows for better precision in the measure.

Fig. 2. Top view images of the cuvettes at two characteristic wavelengths showing the presence of PET MPs (top figure) and PP MPs (bottom figure).

For each pixel, the created decision table is interrogated and enables to determine the plastic types at each pixel and therefore locate, count, define the size and shape of the different MPs in the measured sample. Figure 2 shows two examples of images taken by HSI, i.e., simultaneously on the same sample and at two different wavelengths, on a mixture of MPs in water. We re-colorized the plastic particles (PET and PP) for better visualization.

4 Conclusion

HSI is a fast and easy technique to identify materials when coupled to machine learning or data processing algorithms. We demonstrated in this work that one can determine the type of MPs in a mixture of many particles in water environment. This technique is known for the storage memory it requires for each sample. However, in our concept, only a few wavelengths or features are needed to retrieve the nature of a pixel. Therefore, one can discard the data after measurements. We believe this technique can further improve the detection and identification of MPs in complex water and help discriminating between the plastic types and other organic or non-organic materials constituting the matrix. It would then be a promising method to perform a rapid screening of samples prior robust chemical/optical analysis.

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**References**


