Microplastic identification in sea water by optical transmittance

C. García,[1] **N. Domínguez**,[1] **P. Castilla**,[1] **C. Pizarro**,[1] **P. Blanco**,[2] **M. Espínola**,[2] **J. Arasa**[2]

[1]Snelloptics, Terrassa, 08221, Spain
[2]Universitat Politècnica de Catalunya, Centre for Sensors, Instruments and Systems Development, Terrassa, 08221, Spain

email: cristina.garcia@snelloptics.com

Summary

This work presents a low-cost strategy for identifying some of the most common microplastics currently polluting our oceans; Polypropylene, PET, Polystyrene and Polyethylene. This strategy is based on the evaluation of the optical transmittance behavior of the plastic pieces at a small number of specific wavelengths.

Introduction

Microplastics have become a worrisome source of pollution in our oceans due to their potential to enter the food chain at all levels and cause harm to marine lifeforms by their tendency to accumulate waterborne toxins due to their large surface/volume ratio [1,2]. These microplastic particles are widespread and ubiquitous in the oceans and enter the marine environment from the breakdown of larger plastic pieces or clothing or directly in the form of plastic granules used as scrubbers in cosmetic products and air-blasting.

Appropriate monitorization of microplastic concentration's spatial and temporal trends is needed to gather the information necessary to evaluate and address the problem [3]. Specifically, the challenges and impact presented by each type of plastic should be evaluated. Such monitorization should include the study of characteristics such as the localization of each type of plastic in the water column, the evaluation of their degradation rate and degradation-induced changes in their density and characteristics.

In this work, a measurement strategy based on optical transmission is proposed in order to develop a low-cost sensor to identify the base material of the microplastics pieces. In order to avoid costly components and time-consuming processing, only specific, carefully selected wavelengths will be used. Two basic difficulties encountered in such a measurement are, on the one hand, the modifications introduced in the transmittance spectrum of the base material by the addition of additives such as colorants, and on the other, the fact that the identification must be invariant with the thickness and/or geometrical shape of the plastic pieces.

Discussion

A large spectral database in the near UV – Vis region has been created for the plastics most commonly found at sea (PP, PS, PET and PE), by analyzing pieces from many different commercial products (bottles, food packaging…).

The optical transmittance spectrum of each material has been analyzed for a wide range of different additives, and characteristics common to all specific varieties have been extracted to make up the characteristic signature of the base material. Instead of relying on absolute transmission values, relative variations in the spectra have been used, ensuring that the identification of the plastic will be independent of the fragment thickness and geometry.

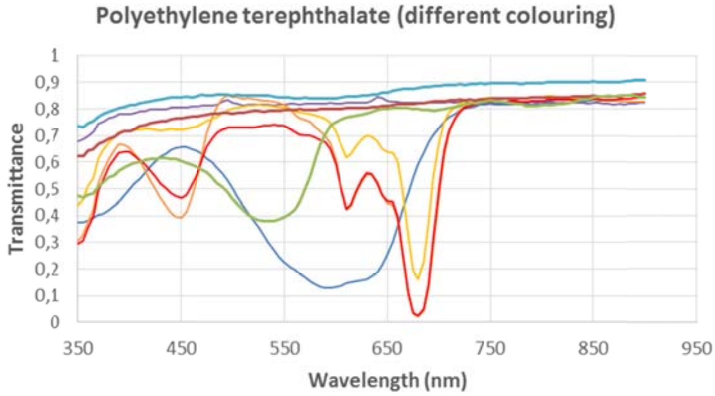

Figure 1 Transmission spectra for pieces of transparent PET with different colouring

Once the characteristic signature of each material was determined, a small number of appropriate wavelengths was selected which were sufficient to distinguish between the different materials.

The result was that it was relatively easy to differentiate PS and PET from all others, while PP and LDPE showed illuminant metamerism in the spectral range. In order to break this metamerism, an additional wavelength in the UV region is being evaluated.

Conclusions

A measurement strategy is proposed for implementation in low-cost sensors to identify the base material of microplastic pieces floating at sea from among the most commonly found types of plastics. This measurement strategy relies on the measurement of the optical transmittance at a small number of discrete wavelengths, in the near UV-vis range. These wavelengths have been determined by a careful study of a large transmittance database of plastic packaging obtained from commercial products, in order to account for spectral changes induced by additives like colorants. The results show that it is possible to identify easily PET and PS, while PP and PE are metameres in this range of illumination. Further studies are being performed to extend the wavelength range further into the UV zone in order to break the metamerism between these two materials.

References

[1] M. Cole, *Marine Pollution Bulletin* ,**Vol. 62**, Issue 12, Pages 2588–2597, 2011
[2] E.L. Teuten, *Philosophical Transactions of the Royal Society B: Biological Sciences*, **Vol. 364**, Pages 2027–2045, 2009
[3] P.G. Ryan, *Philosophical Transactions of the Royal Society B: Biological Sciences*, **Vol. 364**, Pages 1999-2012, 2009