

Computational identification of plastic debris in the marine environment

The presence of plastics on the marine environment has several dangerous effects on the aquatic living organisms. Plastics have high chemical stability and are invariant with respect to the degradation agents. Their accumulation on sea surface produces zones of anoxia and causes the death of all the living organisms entrapped in the net of plastics. Plastic debris can also concentrate several pollutants (polychlorobiphenyls, hydrocarbons) with consequent toxic effects on the living organisms. At last, small size plastics, the so called microplastics could be ingested by the organisms and then enter the trophic chain with not fully known effects.

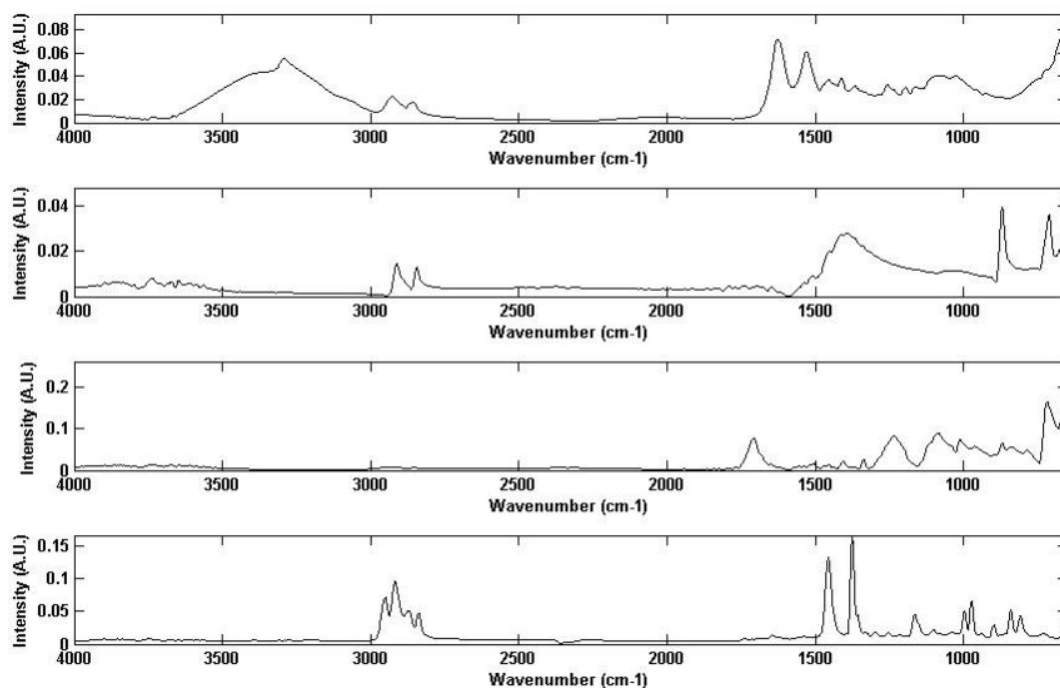


Fig. 1. Some examples of plastic typologies found in the marine environment. From the upper to the bottom plot they are nylon, polyethylene oxide, polyethylene terephthalate, polypropylene.

The analysis and the identification of the chemical structure of plastic debris is the first step to study their effects. Plastics are polymeric materials like polypropylene, polyethylene, nylon, polyethylene terephthalate, made of different starting chemical materials. Nowadays more than twenty typologies of plastic materials are known and used for commercial and industrial purposes and all them can enter the marine environment due to human activities. So the identification of a

plastic polymeric material is fundamental to discover their effects.

There are many instrumental methods to identify the chemical composition of plastic debris, scanning electron microscopy, X ray spectroscopy and infrared (FTIR) spectroscopy. This last one has been recognised as the most versatile analytical method to analyse plastics. However, its use requires a skilled operator because a FTIR spectra of a plastic can consist of several bands typical of its composition and sometimes the final spectrum is hardly to be interpreted (Fig. 1).

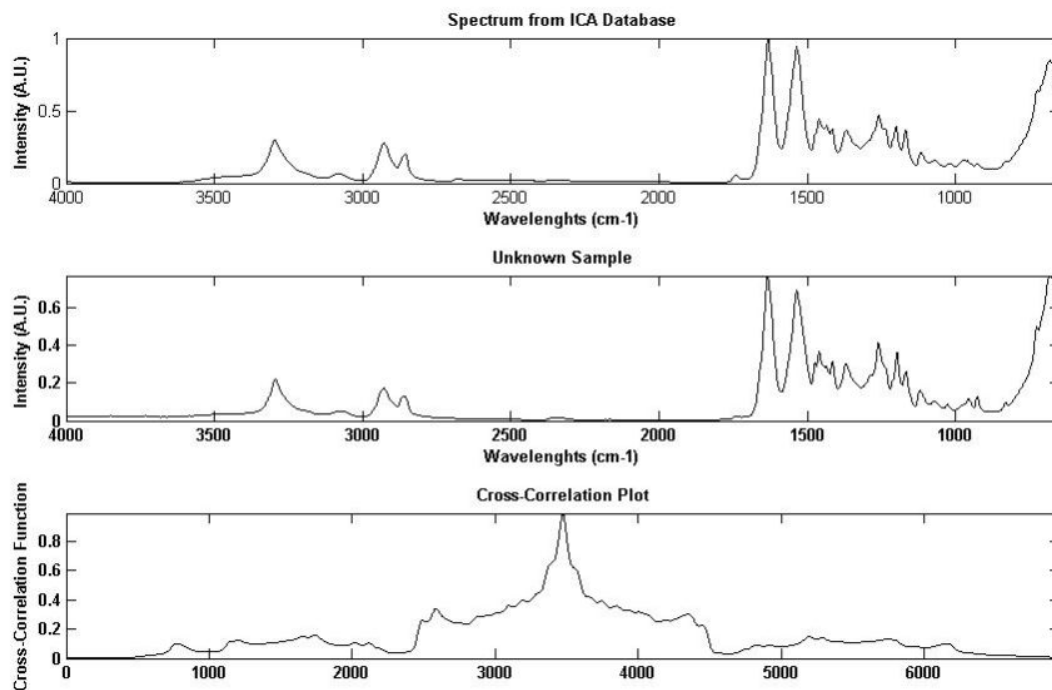


Fig. 2. An example of plastic fragment found in the stomach of the marine turtle *Carretta carretta*. Upper plot spectrum form the database; middle plot plastic sample to be identify with related correlation coefficient; bottom plot, crosscorrelation function supporting chemical analysis.

With this aim to support the chemical analysis of plastic debris for the marine environment, our research group has developed an analytical approach to analyse plastic debris by FTIR spectroscopy without requiring a skilled operator. We collected almost two hundred plastic materials coming from several industrial and domestic activities in a digital database. Then we developed a computational approach based on three different statistic measurements called correlation coefficient, cross correlation function and Mahalanobis distance. The three software routines corresponding to the statistic measurements allow to establish a quantitative index of structural similarity among the unknown (i.e. plastic) spectra and the spectra of the digital

database, without requiring the examination of all the band positions in the spectra. Figure 2 reports the example of the chemical identification of a plastic found in the stomach of a marine turtle *Carretta carretta* made of nylon. The application of this computational approach requires not more than two minutes to assess the chemical composition of a plastic sample.

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Publication

[FTIR spectroscopy supported by statistical techniques for the structural characterization of plastic debris in the marine environment: Application to monitoring studies.](#)

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Mar Pollut Bull. 2016 May 15