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Pyrolysis-GC/MS: a powerful tool for microplastics identification

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Investigate, evaluate, protect

Background

Plastic pollution has gained a large interest in the scientific community because plastic particles are found in marine environments. Moreover, ingestion of microplastics (MP) particles (<5 mm) by numerous seafood products (bivalves and fishes) has been demonstrated. Consequently MPs can represent an emerging risk for human consumption of seafood products. However, only few studies performed the identification of plastic polymer from inorganic debris with reliable methods such as Fourrier Transform infared, Raman spectometry or Pyrolysis-GC/MS (Py-GC/MS).

Py-GC/MS has been recently used for microplastics identification and it has the advantge to be relevant to specifically identify plastics polymers and their additives.

Aims

The purpose of this work was 1) to develop a method using Py-GC/MS to identify multiple plastic polymers and 2) to apply this method on MP found in the environment.

Pyrolysis-GC/MS principle

a Insert a cupule containing the sample on the auto-sampler device

b Pyrolysis of the sample at 600°C for one minute

c Transfert of the pyrolysis products to the GC/MS device

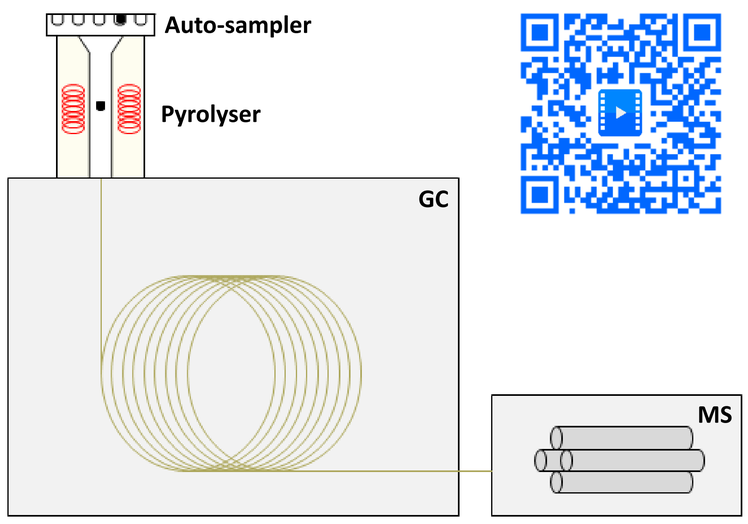


Figure 1: Schematic diagram of Pyrolysis-GC/MS

d Obtention of a pyrogram (chromatogram after pyrolysis) and an associate mass spectrum

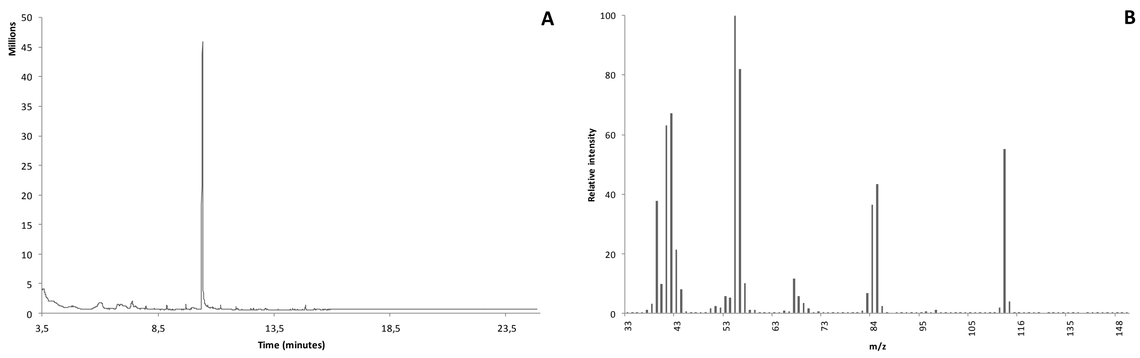


Figure 2: Typical pyrogram obtain after the pyrolysis of PA-6 sample (A) and the associate average mass spectrum (B)

e Identification of the sample using databases

Materials and methods

1. Pyrolysis of fifteen reference material

High and low density polyethylene (HDPE & LDPE), polypropylene (PP), expanded polystyrene (ePS), crosslinked polystyrene (PSXL), polystyrene (PS), poly(methyl-methacrylate) (PMMA), polylaurylactam (PA-12), polycarprolactam (PA-6), polyethylene terephtalate (PET), polyurethane (PUR), polytetrafluoroethylene (PFTE), unplasticized polyvinyl chloride (uPVC), polycarbonate (PC) and cellulose acetate (CA)



2. Pyrolysis of microplastics sampled on a local beach (France)

. Verification of the Py-GC/MS method

. Creation of a database

Application of the developped method and use of the database to identified field samples

Results

1. Polymer identification of plastic reference

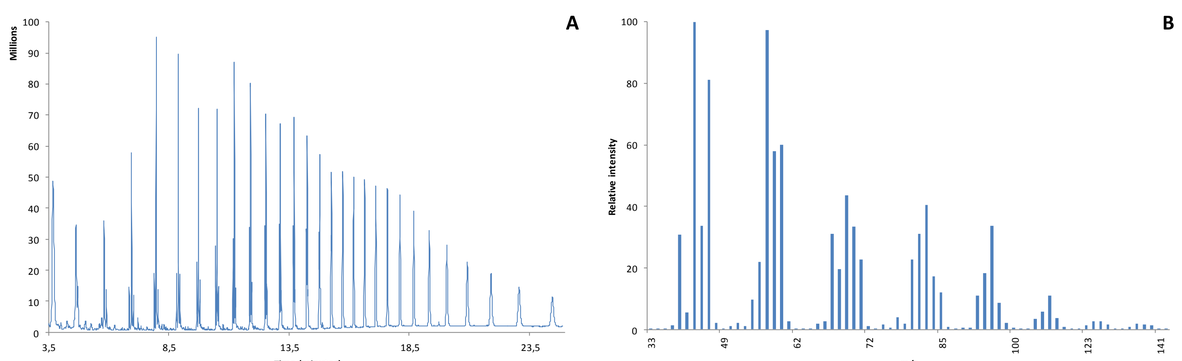


Figure 3: Typical pyrogram obtain after the pyrolysis of HDPE sample (A) and the associate average mass spectrum (B)

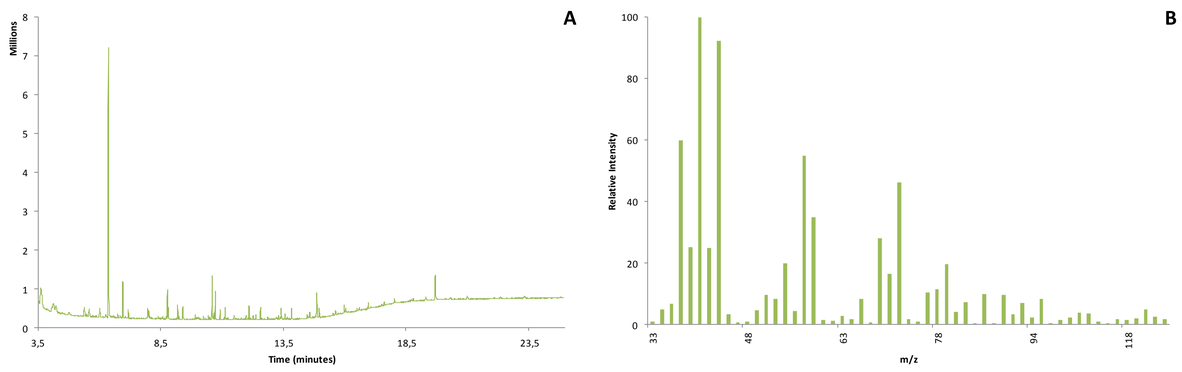


Figure 4: Typical pyrogram obtain after the pyrolysis of PP sample (A) and the associate average mass spectrum (B)

All fifteen families were succefully identified. Typical pyrograms and average mass spectrums of PA-6 (Fig 2), HDPE (Fig 3) and PP (Fig 4) are shown.

This first step allowed the creation of our own database in addition of the database provided by the supplier.

However, for PE and PS, this method is not able, for now, to discriminate the type of polymerization.

2. Polymer identification of plastics from the environment

Fifty microplastics collected on a local beach (France) were used to apply the polymer identification method using Py-GC/MS.

Polymer identification was successful for 98% (Fig 5) of the analyses. It appeared that PE and PP were the more abundant polymer found (Fig 5).

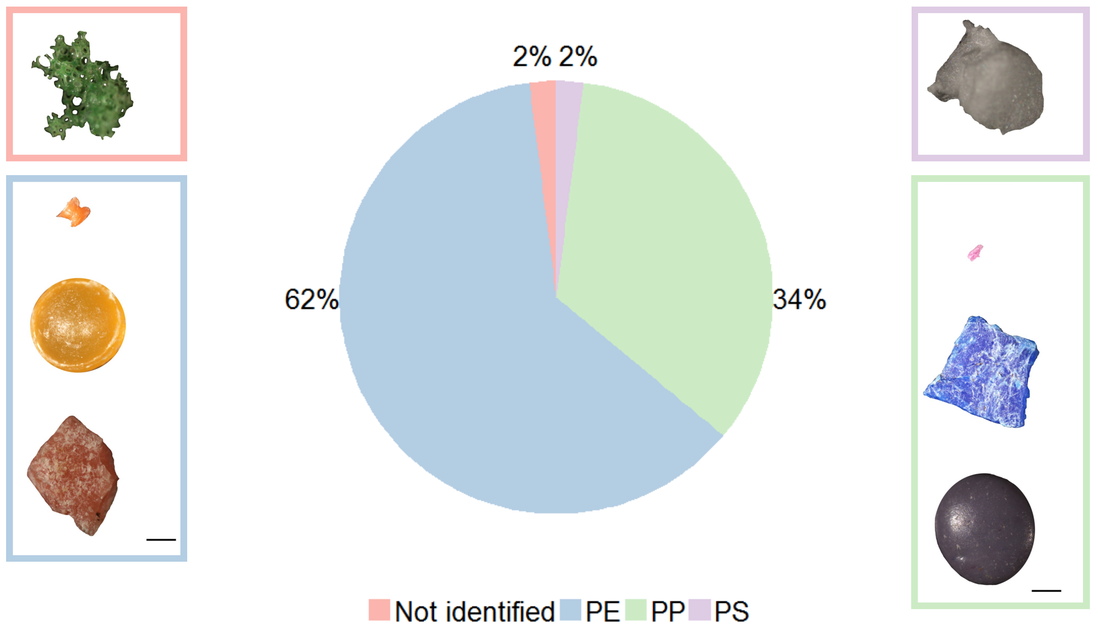


Figure 5: Proportion of polymer types found in microplastics from a local beach (France) and pictures of some of the identified microplastics by Py-GC/MS (scale bar: 1mm)

Conclusion

Here, Pyrolysis-GC/MS was successfully used to identify microplastics found in the marine environment and a database was created using fifteen type of plastic references. This polymer identification technique could be used in large monitoring program and to specifically identify microplastics found in seafood products.

Future work

Method to accurently identied microplastics fibers will be develop shortly and the current method will be tested to identify microplastics as smaller as possible.

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