White Paper

Environmental Research

# Advancing Research of Plastics in the Environment Using the Agilent Cary 630 FTIR Spectrometer

## Plastic pollution studies published by global research groups

## Introduction

Plastic pollution has become a high-priority area of study in recent years due to the increasing prevalence of plastics in the environment. Currently, researchers have a limited understanding of the impact of plastic pollution on human health, how it affects wildlife and their habitats, and its long-term effects on the environment. An important step in overcoming this pressing global environmental issue is the advancement of research relating to the identification of plastic waste and microplastic particles.

Fourier transform infrared (FTIR) spectroscopy is well suited to the identification of different types of plastic in different sample matrices, providing reliable, high-quality data, and cost-effective analyses. This white paper highlights how Agilent FTIR instrumentation is providing workflow solutions that help analysts investigate the impact of plastic pollution on the environment.

## Identification of plastic in environmental samples by FTIR

FTIR spectroscopy is a well-established and powerful analytical technique that provides information on the composition of environmental samples. Even though it is a mature spectroscopic technique, advances in FTIR sampling interfaces have extended its flexibility and use. The quick and easy qualitative and quantitative analysis of polymers is one example application where sampling interfaces have broadened the scope of FTIR.

## Interchangeable sampling modules

The Agilent Cary 630 FTIR spectrometer is an ultra-compact, flexible, and high-performance benchtop FTIR instrument that includes many ease-of-use features to simplify operation by nonexpert users. The innovative Cary 630 FTIR can be configured with a range of interchangeable sampling accessories that integrate with the optomechanical system of the instrument (Figure 1). The versatile modular design means that the Cary 630 FTIR provides the configuration flexibility needed for the robust and reliable analysis of unknown plastics in environmental samples.

In a multi-user setting, a robust and reliable FTIR instrument is key to preventing downtime and reducing the risk of compromised data. A walk-up system that is easy to learn and that requires minimal training is an asset in a busy lab environment. The field-proven, robust optomechanical system of the Cary 630 FTIR has been shown to deliver outstanding performance and reproducibility, even in humid and tropical conditions.

**Figure 1.** Interchangeable sampling modules for the Agilent Cary 630 FTIR.

These design and performance features make the Cary 630 FTIR ideal for the identification of plastics in environmental samples in both research and routine quality assurance (QA) labs.

The Cary 630 FTIR spectrometer is complemented by the powerful and innovative Agilent MicroLab software, which uses an intuitive pictorial interface to guide users through the steps of the analysis, from sample introduction to reporting. The software automatically detects which sampling accessory is installed, applies the required settings, and loads instructive images that are specific to the sampling accessory.

The software allows analysts to identify unknown compounds by automatically comparing the FTIR spectrum of an unknown sample with a library of spectra of known compounds. The results are color-coded to help users interpret the data and take appropriate action (Figure 2).

Agilent also offers MicroLab Expert, an advanced FTIR spectroscopy software for the Cary 630 FTIR that provides a higher level of flexibility and spectral visualization for more sophisticated data processing.

The Cary 630 FTIR spectrometer with the MicroLab software form an ideal solution for the identification of diverse sample polymer types, using a sampling module and method tailored to the application. As an example, Figure 3 shows the Cary 630 FTIR equipped with the attenuated total reflectance (ATR) module for the analysis of films or pellets.

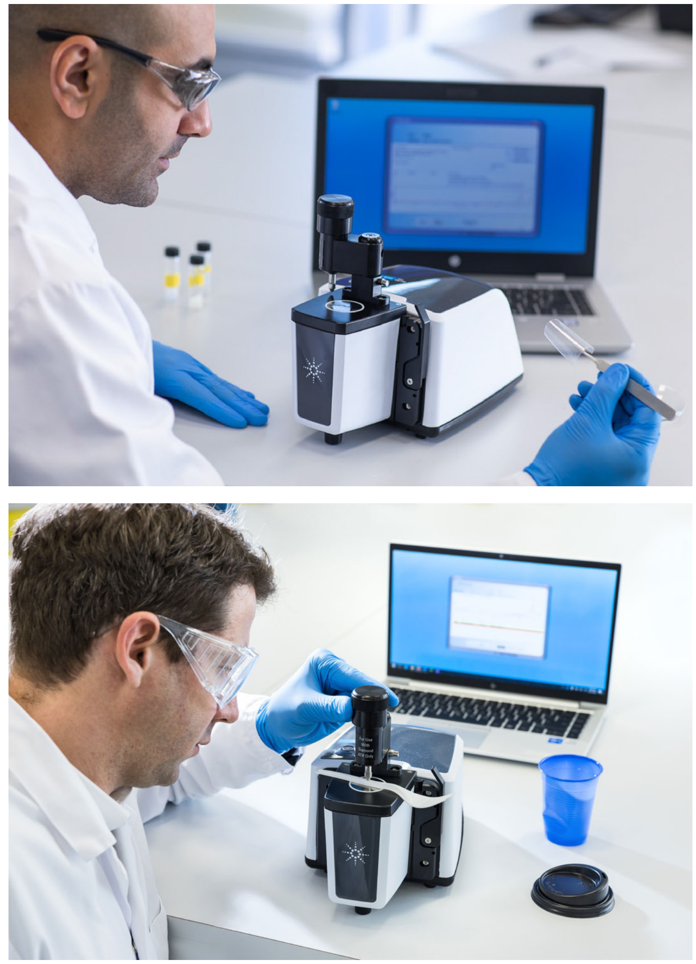
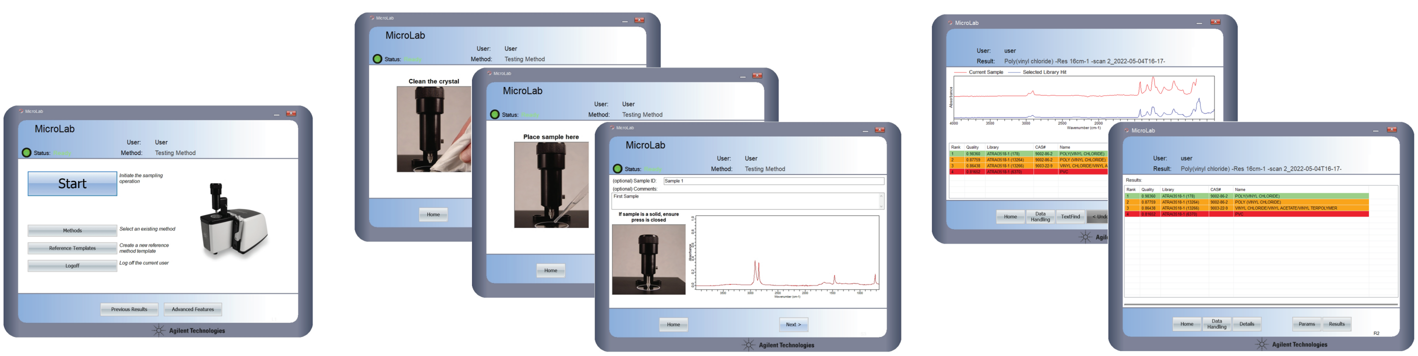


**Figure 3.** Plastic film and plastic waste analysis using an Agilent Cary 630 FTIR with ATR sampling module.




1 Start the analysis

2 Follow the picture-driven software guidance

3 Instantly receive color-coded, actionable results

**Figure 2.** Three simple steps using Agilent MicroLab software and an Agilent Cary 630 FTIR make performing an analysis straightforward and simplify plastic-identification. The picture-driven software also reduces training needs and minimizes the risk of user-based errors.

## Environmental research applications using FTIR

Research-groups located around the world have used Agilent FTIR instrumentation for the analysis of plastics in environmental samples, as summarized in the following examples:

### Plastic debris occurrence, convergence areas, and fin whale feeding grounds in the Mediterranean marine protected area Pelagos Sanctuary: A modeling approach

Fossi *et al.* investigated the correlation between simulated plastic distribution data and the distribution of plastics in liter-samples of seawater collected from the surface of fin whale feeding grounds. The researchers used a Cary 630 FTIR in transmission mode and MicroLab software to identify the abundance and identity of macro- and microplastic polymers in the samples. To identify the polymers, the built-in similarity algorithm in the MicroLab software searched three different Agilent polymer spectral databases, followed by a visual analysis comparison of characteristic bands in the reference spectrum. Polyethylene was the most abundant polymer detected in the seawater samples, likely due to fragmentation of larger items.[1]

### Plastic ingestion by blue shark *Prionace glauca* in the South Pacific Ocean (south of the Peruvian Sea)

Fernandez and Anastasopoulou studied plastic ingestion by 136 blue sharks (*Prionace glauca*) in the south Pacific Ocean. The Cary 630 FTIR was used to identify polymer type, which was mainly pieces of plastic bags made of polyethylene. The FTIR analysis was performed using a self-generated polymer library (i.e., spectra of reference polymer types provided by industry).[2]

### Occurrence and characterization of surface sediment microplastics and litter from North African coasts of the Mediterranean Sea: preliminary research and first evidence

Tata *et al.* carried out a study to investigate the abundance of macro- and microplastics along the North African coast. Samples were collected from surface sediments at four locations and studied by FTIR. A Cary 630 FTIR equipped with an ATR module operating at a range of 4,000 to 650 $cm^{-1}$ was used to identify polymer type. To identify the polymers, the fingerprint regions of sample spectra and spectra generated from known polymers were compared using the method in the software. The main polymers found in this region were polyethylene, polypropylene, polyethylene terephthalate, polystyrene, butyl Branham, ethylene propylene, and cellulose triacetate.[3]

### The plight of camels eating plastic waste

Eriksen *et al.* reported the ingestion of anthropogenic waste by dromedary camels (*Camelus dromedarius*) in the United Arab Emirates (UAE). The ingested waste was identified as a collection of tightly packed indigestible materials such as plastics, rope, other litter, and salt deposits. These materials got trapped in the digestive system of the camels, forming a large stone-like mass (polybeozars). Polybeozars were found to be a contributing factor in the regional mortality rate of 1% of camels since 2008. For the identification of the plastic content of the stone-like mass material, a Cary 630 FTIR spectrometer with a diamond ATR accessory was used. Library searches were performed using the Agilent Polymers ATR library, and best matches were calculated using MicroLab software.[4]

### Developmental toxicity of plastic leachates on the sea urchin *Paracentrotus lividus*

Rendell-Bhatti *et al.* studied the effects of plastic pellet leachates on the sea urchin (*Paracentrotus lividus*). The microplastic leachates exhibited severe and consistent developmental abnormalities in *P. lividus* at different life stages (embryonic and larval). To identify the polymer composition of each environmental sample collected, a Cary 630 FTIR with an ATR module was used.[5]

### Grain size-dependent distribution of different plastic types in coarse shredded mixed commercial and municipal waste

Möllnitz *et al.* investigated the type of plastic in coarse shredded mixed commercial and municipal waste in Austria. Nine types of plastic (low-density polyethylene, high-density polyethylene, polypropylene, polyvinyl chloride, polyurethane, polyethylene terephthalate, polystyrene, polycarbonate, and polyamide) were identified and crossed-checked against a reference library using a Cary 630 FTIR fitted with an ATR module with a diamond crystal.[6]

### Investigation of microplastic pollution in Arctic fjord water: a case study of Rijpfjorden, Northern Svalbard

Bao *et al.* investigated microplastic contamination in terms of abundance, composition, and distribution in the marine environment of Rijpfjorden, Northern Svalbard. A total of 1,010 microplastic particles and 14 mesoplastics were identified from 41,038 particles in eight samples from the Rijpfjorden. The dominant microplastics were polyurethane, polyethylene, polyvinyl acetate, polystyrene, polypropylene, and alkyd varnish. For particles larger than 500 µm, a Cary 630 FTIR was used to identify polymer types. An Agilent 8700 laser direct infrared (LDIR) chemical imaging system was used to detect and identify microplastics in equivalent sphere diameters below 500 µm.[7]

## Agilent solutions for environmental research

Agilent is advancing plastics and microplastics research across the world, offering a range of instruments, both benchtop and portable handheld, to analyze plastics and microplastics onsite, in laboratories, and outdoors in remote environments, delivering immediate and real-time results.

As shown in the application examples, research groups are using the Cary 630 FTIR to advance the understanding of plastic pollution through the study of a variety of environmental sample-types.

In addition to the Cary 630 FTIR, Agilent offers a range of instruments for the analysis of plastics and microplastics, onsite, in laboratories, or outdoors in remote environments, ensuring real-time results.

**Agilent 8700 LDIR Chemical Imaging System**

Provides a sophisticated new approach to chemical imaging and spectral analysis for microplastics.

**Agilent 4300 Handheld FTIR Spectrometer**

The first of its kind, using lightweight ergonomics, ease-of-use, ruggedness, and flexibility in one system.

**Agilent 4500 Series Portable FTIR Spectrometer**

Onsite analysis of incoming materials and outgoing finished products in the chemical, petrochemical, food, and polymer industries.


**Agilent 5500 Series Compact FTIR Spectrometer**

A compact, at-site analyzer designed to provide accurate results rapidly and reliably, day after day.

## Conclusion

The Agilent Cary 630 FTIR equipped with an ATR sampling technology is an effective spectrometer for analyzing polymers and copolymer blends in environmental samples. The combination of its compact size, sampling technology, performance, speed of analysis, and intuitive software enables qualitative methods for polymers to be developed rapidly and deployed in environmental research applications.

The Cary 630 is part of a wider range of instrumentation offered by Agilent for the analysis of plastics and microplastics. The choice of instrument will depend on the sample-types, location of samples, and the objectives of the analysis.

## References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## Further information

– Agilent Cary 630 FTIR Spectrometer
– Agilent MicroLab Software
– Agilent MicroLab Expert Software
– FTIR Analysis & Applications Guide
– FTIR Spectroscopy Basics - FAQs
– ATR-FTIR Spectroscopy Overview
– Microplastics Technologies FAQs

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