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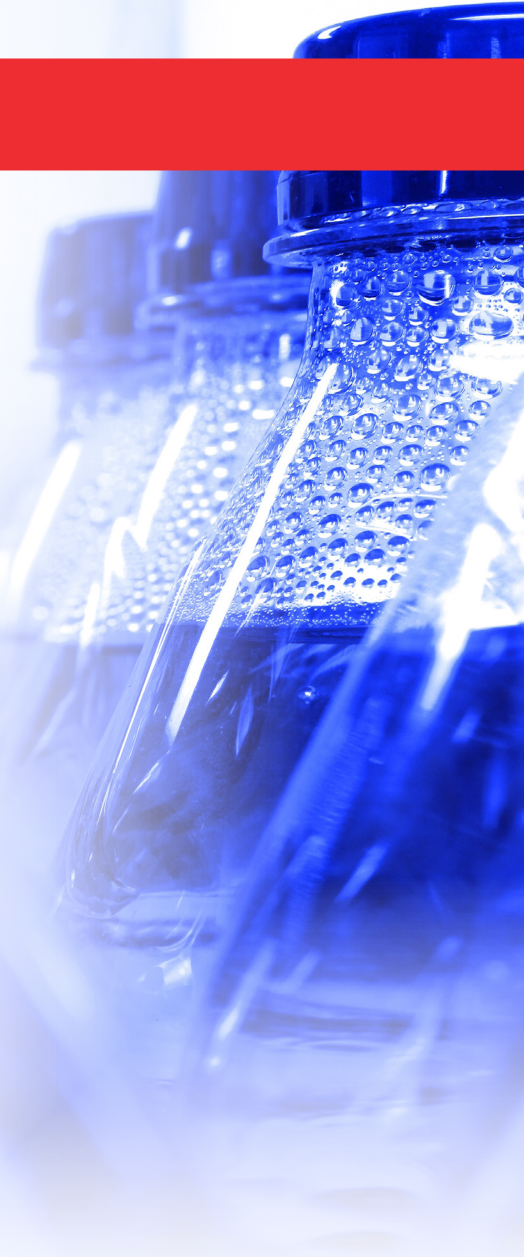
Microplastics in bottled water

Abstract

Microplastic pollution in water, land or even air has become an increasing concern for society. In addition to its detrimental impact on ecosystems and human health, recent revelation that many bottled water and other beverages products contain microplastic contamination also put many corporations at risk of negative publicity and brand erosion. Combating the microplastic pollution requires a thorough understanding of its sources and pathways, which starts from the detection and identification of microplastics in different types of samples. The combination of the Thermo Scientific™ Nicolet™ iN10 MX Infrared Imaging Microscope, Thermo Scientific™ DXR2xi Raman Imaging Microscope, Thermo Scientific™ OMNIC™ Picta™ Software, and polymer libraries from Thermo Fisher Scientific offers a complete solution to address the challenge in analyzing microplastics of a wide size range (1-5000 µm).



Microplastics…a growing global concern

The widespread presence of microplastic material (small synthetic plastic particles <5 mm) in the environment has gained considerable attention in recent years, as regulators, researchers, and manufacturers race to understand its sources and pathways, to assess its impact on ecosystems and human health, and to develop effective means to tackle the issue. Products ranging from simple synthetic fibers in clothing to plastic microbeads in consumer products have, over time, left residual materials in the environment, especially in the aquatic environment. Starting from the accumulation of microplastics in ocean water, microplastics are infiltrating fresh water, land and even air. Recent studies have revealed a much more pervasive problem than many feared. Overall, 83% of the tested tap water samples were contaminated with plastic fibers, of which the US has the highest contamination rate at 94% and Europe has the lowest at 72%. The research at the State University of New York at Fredonia indicates that 93% of tested bottled water showed signs of microplastic contamination, and the contamination is at least partially coming from the packaging and bottling process. Microplastic fibers and fragments were also found in beer, honey, sugar and air.[1]

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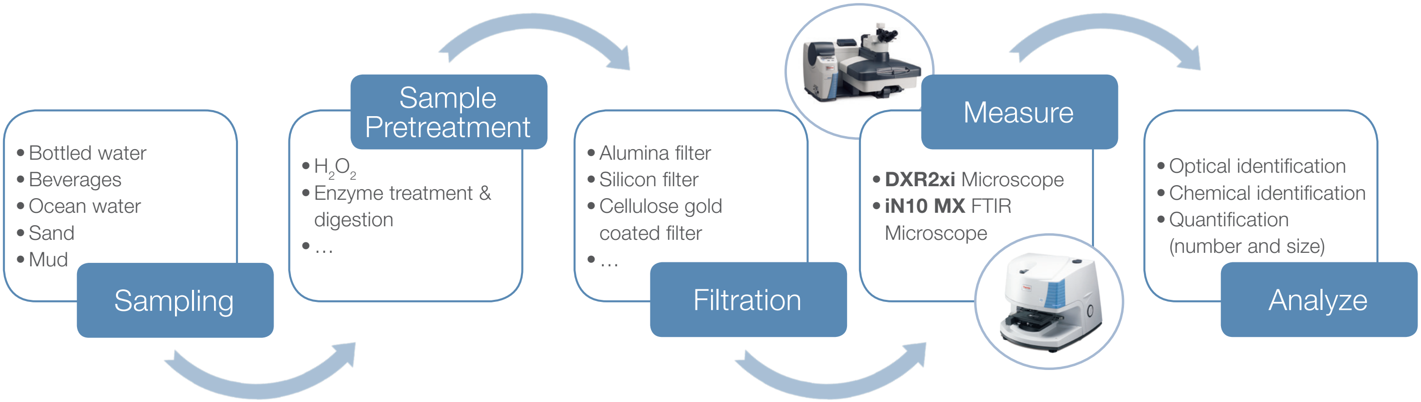

Figure 1. Schematic showing the typical workflow for microplastics analysis.

The Thermo Fisher Scientific solution

Figure 1 illustrates a typical workflow for microplastics analysis. After pre-treatment, where necessary, to remove biogenic material, aqueous samples are passed through filters. Dried filters are then directly placed onto the sample stage of microscopes for microspectroscopic analysis.

The Nicolet iN10 MX FTIR microscope is ideally suited for the analysis of microplastic particles >10 µm. An example is demonstrated in Figure 2. The visual image (Figure 2A) consists of more than 200 video captures combined into a mosaic covering approximately 1 cm^2. A total of ~17,500 spectra were collected in ~30 min (50 µm steps and 0.1 s/spectrum). Representative spectra from the filter itself and the spheres are shown in Figure 2B. Using the polyethylene spectrum from a reference standard, a correlation map relating to each spectrum in the map was constructed (Figure 2D), where the red spots are strongly correlated to polyethylene while the blue field is uncorrelated. The particle wizard of the Picta software can complete the analysis automatically. After a region from the video image is selected, the software identifies the target particles and proceeds to produce spectra for each particle. These spectra are then searched against a spectral library, and a report catalogs the number of particles in the inspection area. The data can then be back extrapolated through the volume of filtered liquid to provide a semi-quantitative measure of the particulate concentrations.

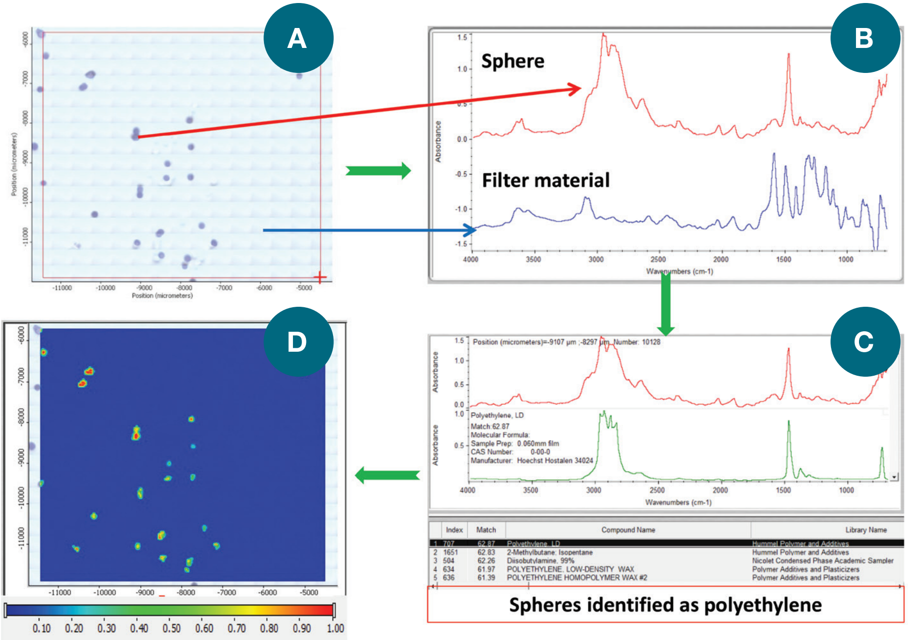

Figure 2: An example of using the Nicolet iN10 MX FTIR microscope for microplastics analysis. (A) A visual image of the filter showing particles; (B) Spectra of the particles and the filter paper; (C) Library searching results of the particles; and (D) Correlation map to the spectrum of the particles.

For particles <10 µm, the DXR2xi Raman imaging microscope offers a powerful solution with a spatial resolution down to 0.5 µm. Figure 3 shows the analysis of a sample of ocean water collected from the Pellestrina beach in the Lagoon of Venice. The software for the DXR2xi Raman microscope recognized and located several particles on the alumina filter from the optical image (Figure 3A). Only the regions of interest, based on predefined criteria, were then selected for spectral acquisition, which effectively minimized the total analysis time. During spectral acquisition, a real-time MCR (Multivariate Curve Resolution) allowed chemical identification of the particles, but also provided direct visualization of the particles of different chemical origins (Figure 3B). For example, all three particles outlined in Figure 3A have a size between 5 to 10 µm. The yellow particles were identified as polypropylene, and the grey one was identified as PV23 Hoechst Laser pigment.

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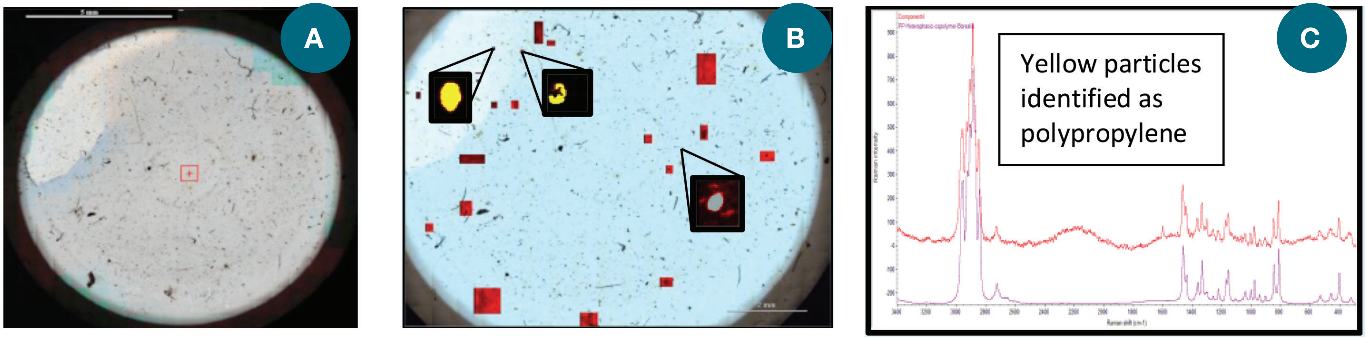

Figure 3. An example of microplastics analysis using the DXR2xi Raman microscope. (A) Video image of the alumina filter with microplastic particles; (B) Chemical image of the filter with microplastic particles; and (C) Spectrum of one of the yellow particles compared to the library spectrum of polypropylene.

Conclusions

The wide size range of microplastics (1-5000 μm) poses a particular challenge for their analysis.
Thermo Fisher Scientific is uniquely positioned to tackle that challenge with an industry-leading product portfolio that includes 1.) the Nicolet iN10 MX FTIR imaging microscope for particle sizes >10 μm and 2.) the DXR2xi Raman imaging microscope for particles >1 μm in diameter. The intelligence built into the Picta software allows for automated analysis in the filter regions where microplastics are present, greatly increasing the analysis efficiency and minimizing the analysis time.

Reference

1. https://www.theguardian.com/environment/2017/sep/06/plastic-fibres-found-tap-water-around-world-study-reveals

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