thermoscientific

Using FTIR to Analyze Microplastics in the Environment

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GOALS AND OBJECTIVES

The goal of this work is to describe the application of infrared spectroscopy to the identification and characterization of microplastics encountered in the environment. This spectral analysis can provide valuable information about the origin of the plastics particles, adsorbed chemicals and possible toxicity.

Observations: Microplastics in oceans and lakes - a significant international issue

Particulates typically microns to millimeters in size
- Origins varied: laundry cycles, synthetic exfoliating cosmetics, spills, landfill runoff, littering
- A sweater can shed thousands of fibers into the water stream
- Synthetic exfoliates now banned or being banned worldwide

Most common materials:
- Polyamide Polyurethane Acrylic PVC PET
- Polyethylene Polypropylene Foamed Styrene
- Higher Density plastic sinks

Specific Applications:
- Material identification: Plastic and amount
- Material contamination: Many polymers are oleophilic
- Material accumulation in organisms: Sub-micron particles
- Material degradation

Image courtesy of Dr. Lorena M. Rios Mendoza, UW-Superior

EXPERIMENTAL

FTIR microscopy is an excellent tool for detecting and identifying polymeric materials. The Thermo Scientific™ Nicolet™ iS20 FTIR Spectrometer configured with the Thermo Scientific™ Nicolet™ iN™ 5 FTIR Microscope shown in Figure 1 was designed for exactly such an application, with automatic beam switching, extreme simplicity in functional design and powerful analysis software. The Nicolet iN5 microscope large field of view makes it easy to locate and target your sample and gives you the spatial resolution necessary to perform chemical analysis with pinpoint accuracy. This is enhanced by the microATR capabilities which enable the analysis with no sample preparation. Here, we use the Nicolet iN5 microscope and germanium (Ge) ATR to analyze reference materials and samples extracted from a consumer product. A benefit of this configuration is that the spectrometer sample compartment remains open for other accessories providing flexibility for busy laboratories.

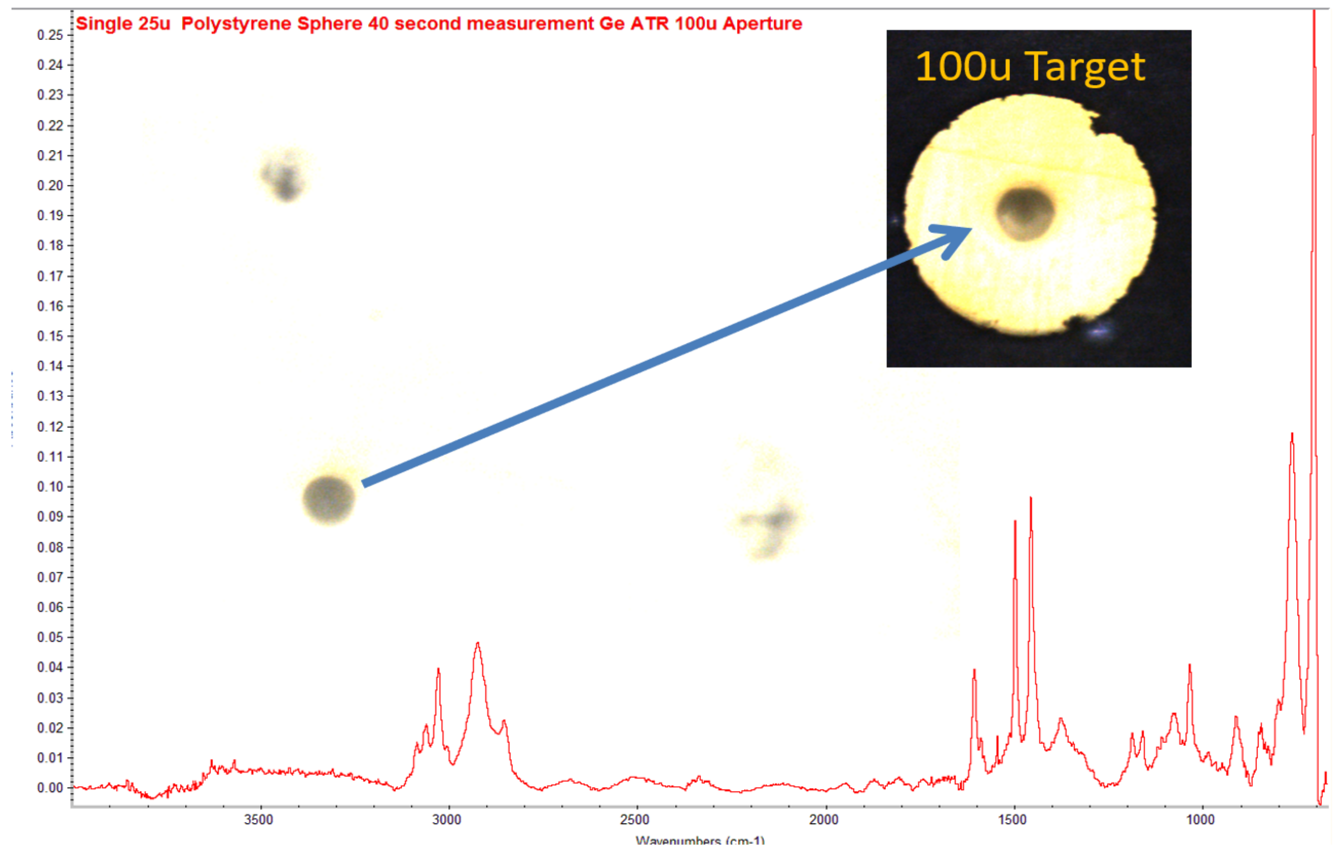
Figure 1. Nicolet iS20 FTIR spectrometer and Nicolet iN5 FTIR Microscope

System configured with high sensitivity liquid nitrogen cooled MCT detector

RESULTS

Figure 2 shows a sparsely populated region where a single, isolated particle could be selected. The circular image is taken through the 100 micron aperture of the Nicolet iN5 microscope. The Ge-tip ATR was inserted and contact made as indicated by a simple red-green light on the Nicolet iN5 system. The resulting spectrum (40 second acquisition) is also shown in Figure 2, clearly indicating that the Ge-tip ATR is properly contacting the particle. The high level match to polystyrene (> 92) further confirms the excellent performance of this combination.

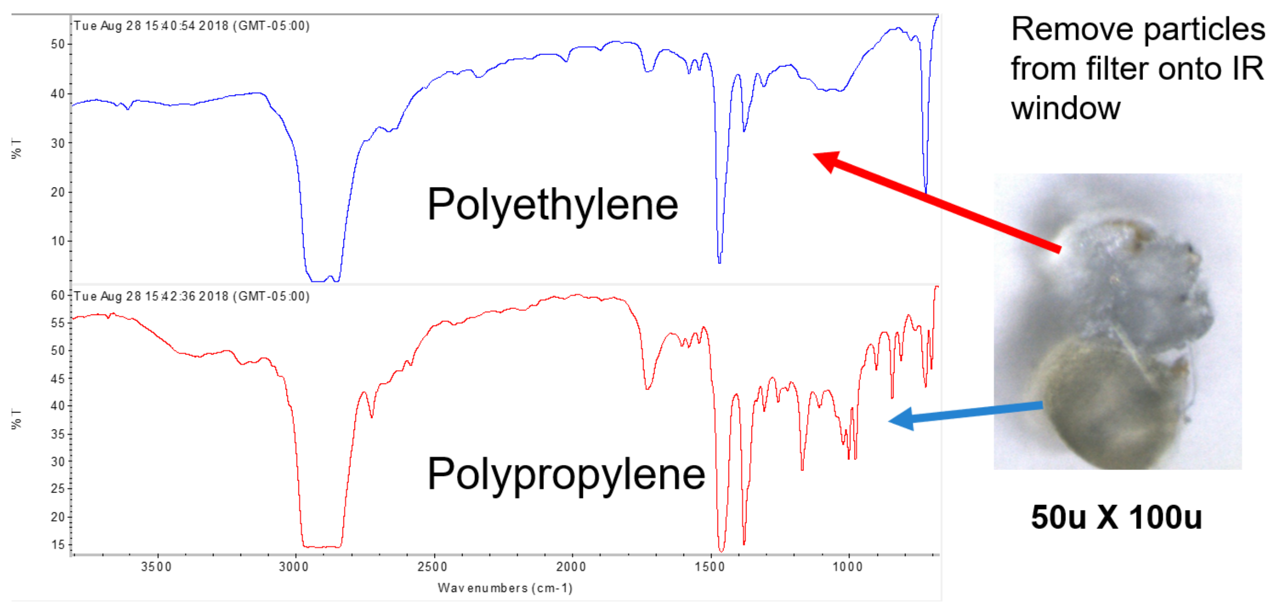
Figure 2. Single 25μ polystyrene bead on glass slide



PLASTICS IDENTIFICATION

The Nicolet iN5 infrared microscope is capable of measuring spectra in transmission and switching to reflectance mode without moving the sample. Figure 3 shows the %T spectra from two microbeads placed on an infrared transparent window.

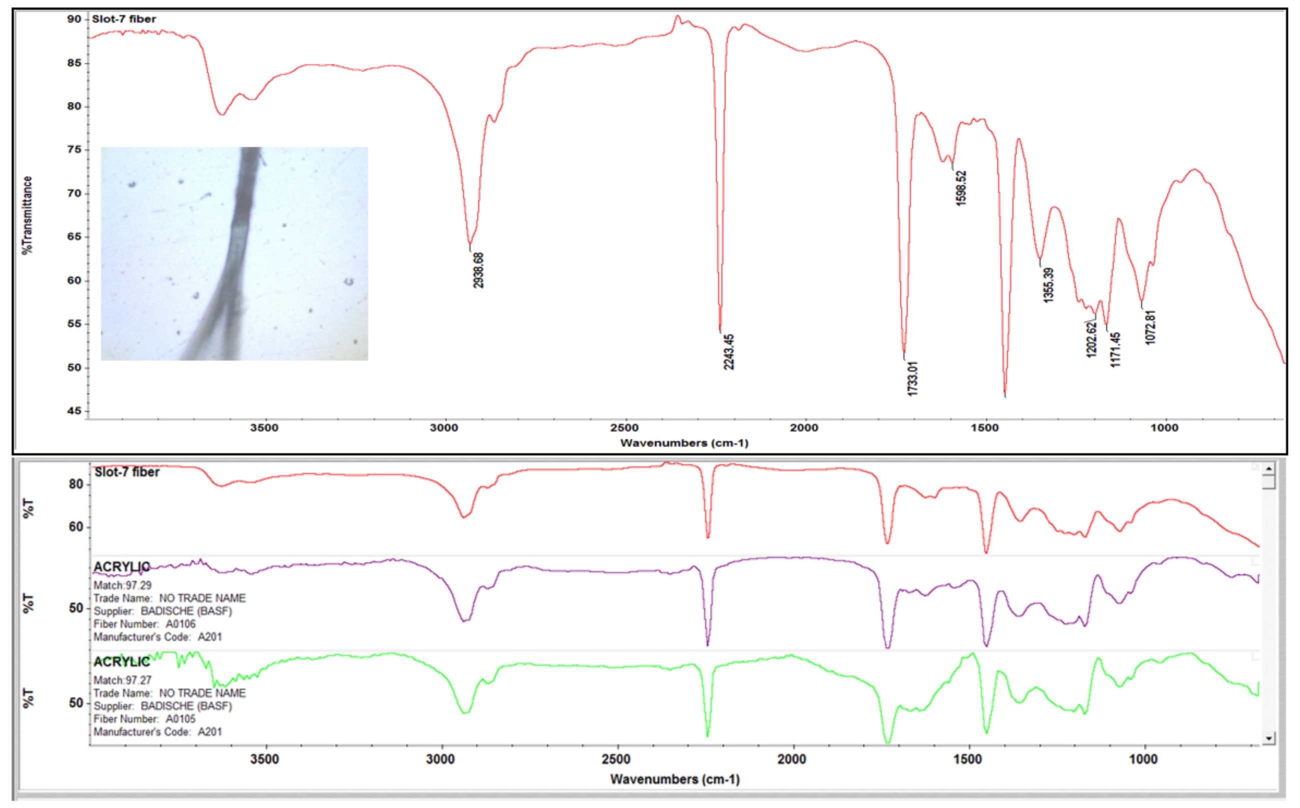
Figure 3. %T Spectra acquired from two microbeads positioned on a 13mm KBr window



FIBER IDENTIFICATION

A major source of microplastics found in the environment is from clothing and fabrics. In the example in Figure 4, a small piece of fiber on a filter is directly measured by ATR. The fiber is clearly identified as acrylic.

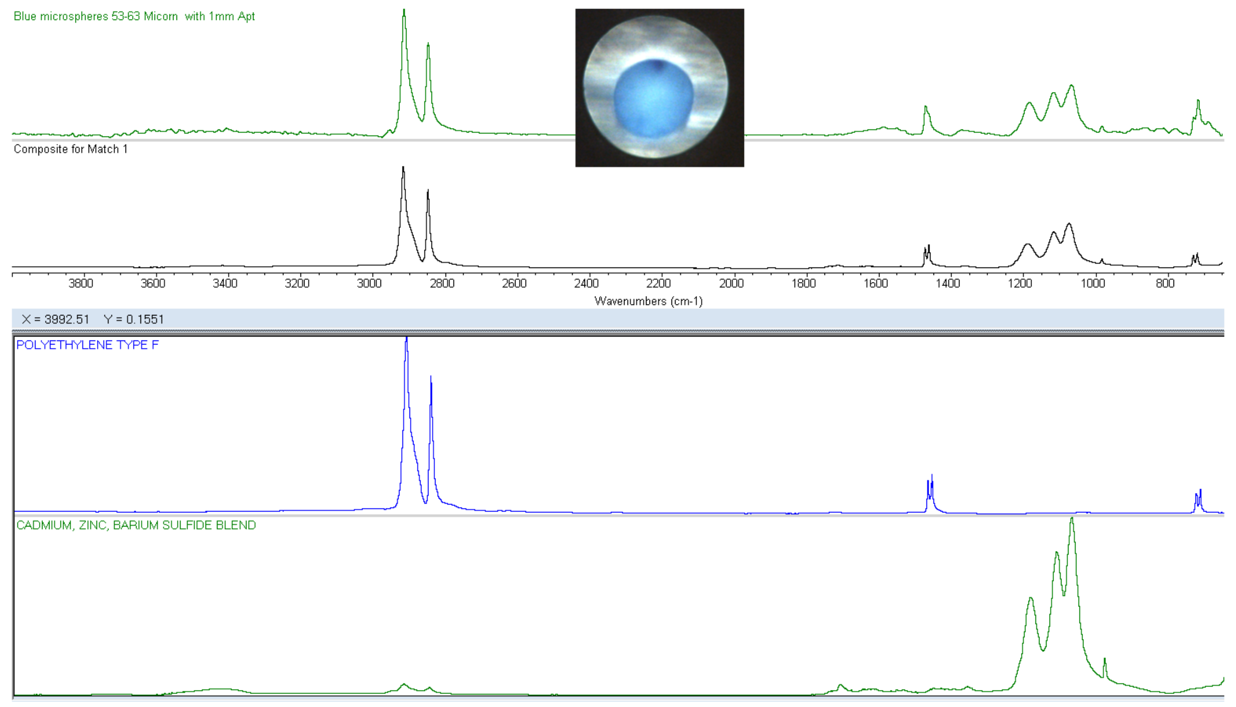
Figure 4. Search results from a clothing fiber. Library searching confirms the fiber is acrylic



MULTI-COMPONENT SEARCH

The Thermo Scientific™ OMNIC™ Specta™ Software multi-component search (MCS) function is a powerful tool for detecting additives or trace components adsorbed on a plastic. In Figure 5 the small blue sphere is identified as polyethylene but appears to contain a second component, indicated by peaks between 1000 and 1200 cm^{-1}. OMNIC Specta MCS identifies both components simultaneously as polyethylene and a barium sulfur compound. The comparison of the measured sample and the calculated composite spectrum confirm barium sulfate as the second component.

Figure 5. Multi-component search results using OMNIC Specta software to identify polyethylene and barium sulfate components of a blue microbead



CONCLUSIONS

The combination of Nicolet iS20 spectrometer and the Nicolet iN5 FTIR microscope is ideally suited for the identification of microbeads and plastics while keeping the spectrometer sample compartment open for other accessories providing flexibility for busy laboratories. The simplicity of operation targets this combination at laboratories with minimal microscopy experience. The most common microplastics are around 25-100 microns in size, for which the microscope and its Ge-tip ATR are perfectly suited. Coupled with OMNIC and OMNIC Specta software, a typical analysis can require no more than a minute. This combination delivers answers with automatic beam switching, visual positioning using manual operations, simple contact-and-analyze ATR and the most trusted software in spectroscopy.

TRADEMARKS/LICENSING

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