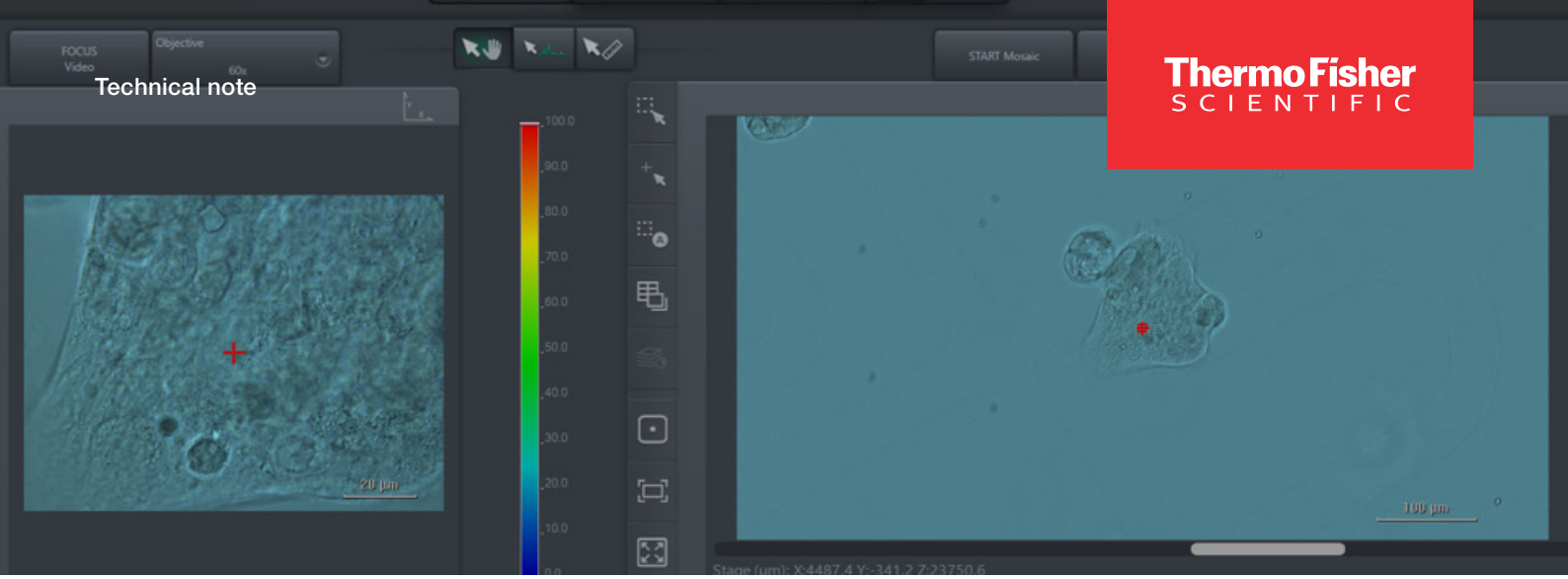
Technical note



Raman identification of intracellular microplastics in respiratory cells using the Thermo Scientific DXR3xi Raman Imaging Microscope

Authors

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Introduction

The presence of microplastics in biological systems is emerging as a major concern in environmental and biomedical research. Recent studies suggest that inhaled airborne microplastics may penetrate deep into the respiratory tract and potentially accumulate within tissues and cells. Understanding the localization and chemical identity of these particles is essential for evaluating their possible biological impact and their potential correlation with pathological conditions.

This study demonstrates the feasibility of identifying intracellular microplastics within respiratory cells via Raman microscopy, using the Thermo Scientific™ DXR3xi Raman Imaging Microscope.

Accurate characterization of intracellular microplastics in biological samples requires careful control of all experimental parameters, including the laser power delivered during Raman measurements. Since laser exposure can induce morphological or biochemical changes, maintaining well-defined and reproducible irradiation conditions is fundamental for generating reliable data and establishing meaningful correlations between microplastic accumulation and potential biological damage. The Thermo Scientific DXR3xi Raman Imaging Microscope addresses this challenge through its laser power regulator technology, an active feedback system that continuously controls and maintains the absolute laser power delivered to the sample. This capability minimizes the risk of laser-induced artifacts and provides greater confidence in the interpretation of experimental results.

Experimental concept

The study was based on exposing animal models to fluorescent polystyrene microplastic particles with an average diameter of 1 µm. Fluorescent labeling enabled preliminary localization of the particles inside respiratory cells by fluorescence microscopy.

Cell preparation, fixation, and stabilization were performed by the collaborating research laboratory. The prepared cells were mounted on microscope slides and maintained in an aqueous environment to preserve cellular integrity during Raman analysis.

Raman analysis with the DXR3xi Raman Imaging Microscope

Raman measurements were performed using the Thermo Scientific DXR3xi Raman Imaging Microscope equipped with a 60x water immersion objective.

The use of water immersion optics provided two major advantages:

- Improved visualization of cellular structures
- Minimization of thermal stress and cellular degradation during laser exposure

Both intracellular and extracellular microplastic particles were analyzed to verify spectral consistency and confirm the chemical identity of the detected material.

Laser power was carefully optimized through the instrument's adjustable laser control capabilities to ensure that analytical conditions did not damage or alter the cellular membrane during measurements.

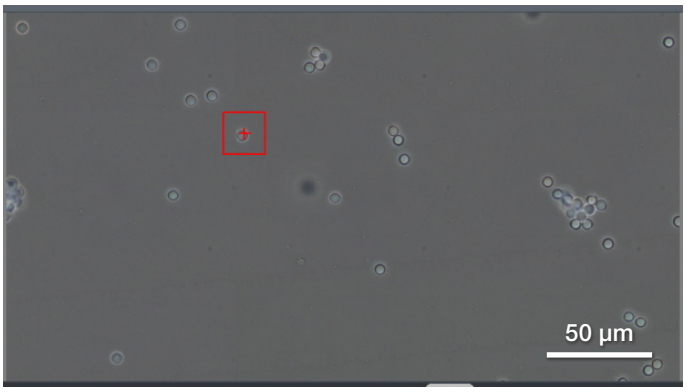
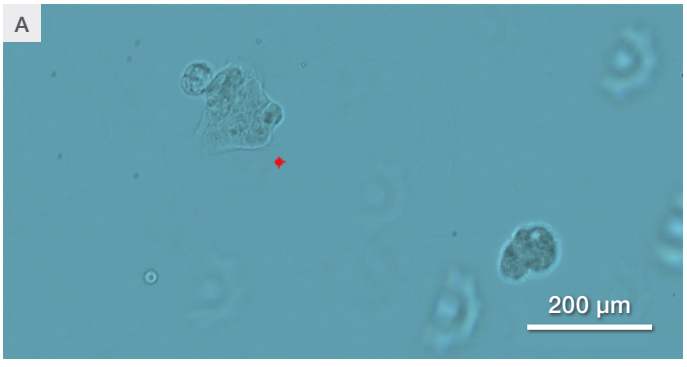


Figure 1. Reference polystyrene microplastic particles.



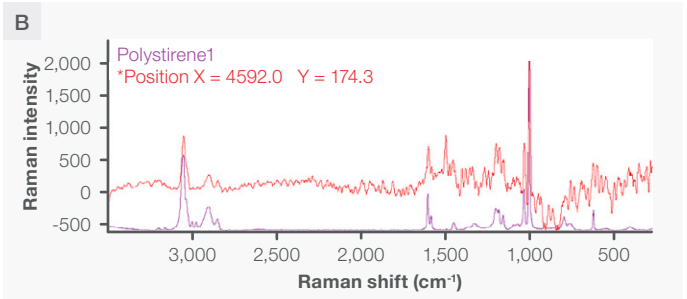


Figure 2. (A) Extracellular polystyrene particle. (B) Corresponding orresponding Raman spectrum with spectral library identification.

Spectral identification

Raman spectra acquired from particles located inside and outside the cells showed identical spectral profiles characteristic of polystyrene.

The DXR3xi spectral search functionality enabled rapid confirmation of polymer identity by matching the acquired spectra with reference polystyrene spectra contained in the spectral database.

The results demonstrated several key aspects of the analysis:

- Intracellular microplastics can be successfully identified by Raman microscopy
- Raman analysis can be performed without detectable cellular damage* under optimized conditions
- Spectral matching allows reliable chemical confirmation of the detected particles

* The evaluation of cellular integrity was performed by the customer using appropriate biological validation models.

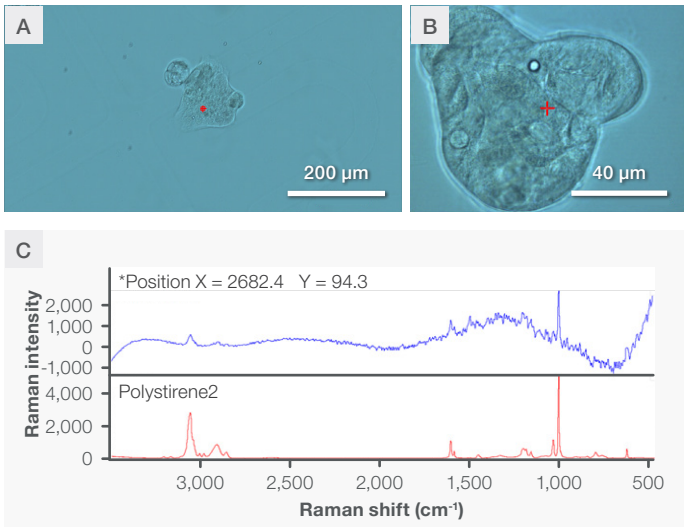


Figure 3. (A) Intracellular polystyrene particle. (B) At higher magnification. (C) Raman spectrum and spectral library identification.

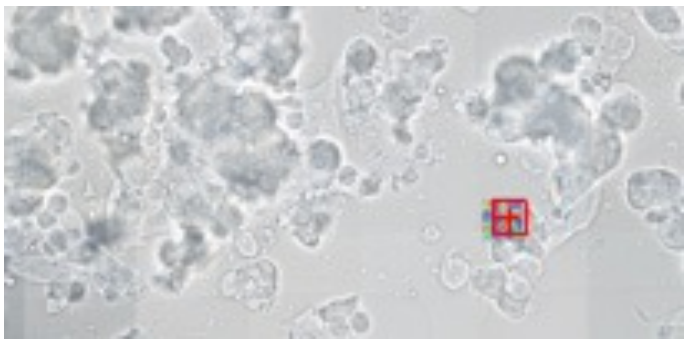


Figure 4. Raman spectral map of the entire cell showing the intracellular polystyrene particle.

Significance

This study demonstrates the feasibility of using Raman microscopy for the investigation of microplastics within biological cellular environments.

The approach opens new possibilities for studying the presence and distribution of microplastics in human tissues and biological systems. In collaboration with biomedical researchers and pathologists, these analytical capabilities may contribute to future investigations into possible correlations between microplastic accumulation and diseases such as cancer or other pathological conditions.

Conclusions

The Thermo Scientific DXR3xi Raman Imaging Microscope demonstrated its analytical capabilities and what it can do in a biological setting:

- Identify intracellular microplastics within respiratory cells
- Preserve cellular morphology through optimized low-power Raman conditions
- Chemically confirm polymer identity through Raman spectral analysis
- Support advanced biomedical investigations involving microplastic contamination in biological tissues

These results highlight the potential of Raman microscopy as a powerful analytical tool for future studies at the interface of environmental science, toxicology, and biomedical research.

Document review summary

- Verified consistency between figures and corresponding scientific descriptions.
- Improved figure captions for clarity, grammar, and scientific style.
- Corrected terminology related to intracellular and extracellular microplastics.
- Standardized Raman spectroscopy descriptions and spectral library references.