Polyethylene Microplastics Revealed in Chicken Liver Tissue by Raman Microscopy

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Introduction

Can microplastics cross biological barriers and accumulate in internal organs? This has become one of the most pressing questions in environmental and biomedical research. While evidence of microplastics in digestive systems is well established, direct identification inside organs remains analytically challenging.

A university research group investigated the hypothesis that sufficiently small polyethylene (PE) microplastics can cross the intestinal barrier and accumulate in liver tissue. This application note describes the analytical approach used to obtain chemically specific evidence of PE particles within the tissue.

Cryo-sectioned chicken liver samples were prepared as a model system. Under optical microscopy, small dark inclusions could be observed within the tissue (Fig. 1). As morphology and optical contrast alone were insufficient to determine their chemical composition, Raman microscopy was used to distinguish potential PE particles from biological structures.

Raman Microscopy for the Smallest Particles

While being the established standard, infrared-based analysis did not provide conclusive identification of polyethylene in the liver tissue. The suspected particles were only approximately 1–5 µm in size, making them difficult to resolve using infrared microscopy.

Raman microscopy was therefore selected because its high spatial resolution enables the chemical identification of particles in this size range. This capability makes Raman spectroscopy particularly well suited for detecting very small microplastic particles within biological tissue.

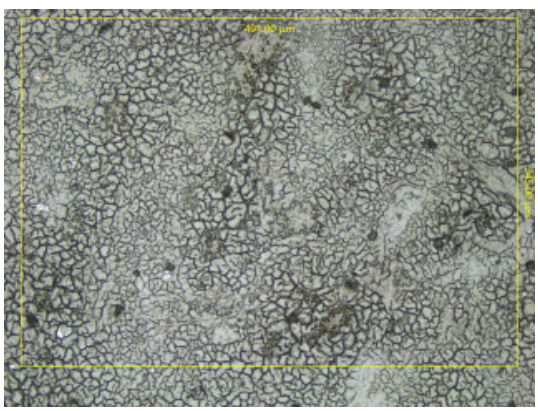

Fig. 1
Microscopic image of a chicken liver cryo-section. Dark spots are suspected to be microplastic particles.

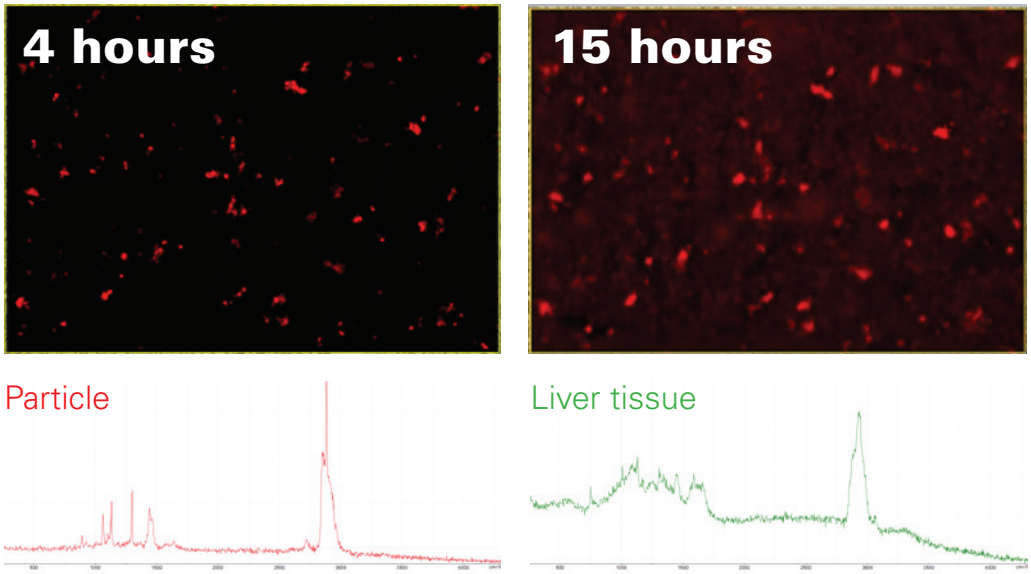

Fig. 2
Comparison of the Raman image acquired with Random Scanning after 4 hours (top left) with the complete 15-hour Raman image (top right). Clearly, most particles have already been found by the algorithm. Found particles were unambiguously identified as PE (bottom left) and clearly stand out from the liver tissue matrix (bottom right).

Results

The mapping area covered approximately 491 × 345 µm, with a spatial sampling resolution of 1.2 µm, resulting in a dataset capable of resolving micrometer-scale inclusions within the tissue matrix. A total acquisition time of 15 hours (Fig. 2, top right) was scheduled for a conventional grid-based Raman mapping, to ensure full coverage.

However, because the target particles were expected to be sparse and unevenly distributed, Random Scanning was used to avoid spending measurement time on tissue regions without relevant signals. By preferentially sampling chemically informative locations within the selected area, this approach increased the likelihood of detecting polyethylene particles while reducing the time required to obtain meaningful results. Read more on this approach in our Product Note R56.

Thus, within the first three to four hours, the system had already identified and characterized most of the polyethylene particles (Fig. 2, top left). The resulting Raman image, even at this intermediate stage, closely resembled the final dataset in both spatial distribution and statistical relevance.

At each highlighted pixel, the characteristic Raman signature of polyethylene was identified. The corresponding full-range spectra (Fig. 2, bottom) confirmed the chemical identity of the particles, providing clear evidence of polyethylene microplastics within the liver tissue.

Conclusion

By combining confocal Raman microscopy and intelligent Random Scanning, this study successfully achieved the direct detection and identification of polyethylene microplastics in liver tissue. Raman microscopy is particularly well suited to the analysis of very small particles in complex biological matrices, where high spatial resolution is essential. It therefore provides a powerful complementary technique for studies that extend beyond the resolution limits of infrared methods. Infrared imaging, however, remains a cornerstone of microplastics analysis because of its unmatched high-throughput screening capabilities and measurement speed.

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