You are what you eat: quantifying chlorine-rich microplastics in mollusks

Unique automation software is enabling researchers to quantify chlorine-containing microplastics in mollusks using scanning electron microscopy.

What are microplastics?

Since their invention, plastics have been lauded for their durability and longevity, but the 21st century has brought with it a new, troubling understanding of plastic degradation and pollution. We are no longer just concerned about the errant plastic bag or even the large, floating mass of plastic waste in the Pacific Ocean; instead, scientists have found that most polymer materials are progressively weathered, producing micro-scale particles that permeate into the environment, waterways, and eventually living organisms.

These "microplastics" (specifically describing any plastic particles less than 5 mm in diameter) are so ubiquitous that they have been found in the **most remote corners of the world**. While their effects on environments and ecosystems are still **an active area of investigation**, there has been some indication that microplastics could potentially sequester environmental pollutants, introducing them into the food supply.

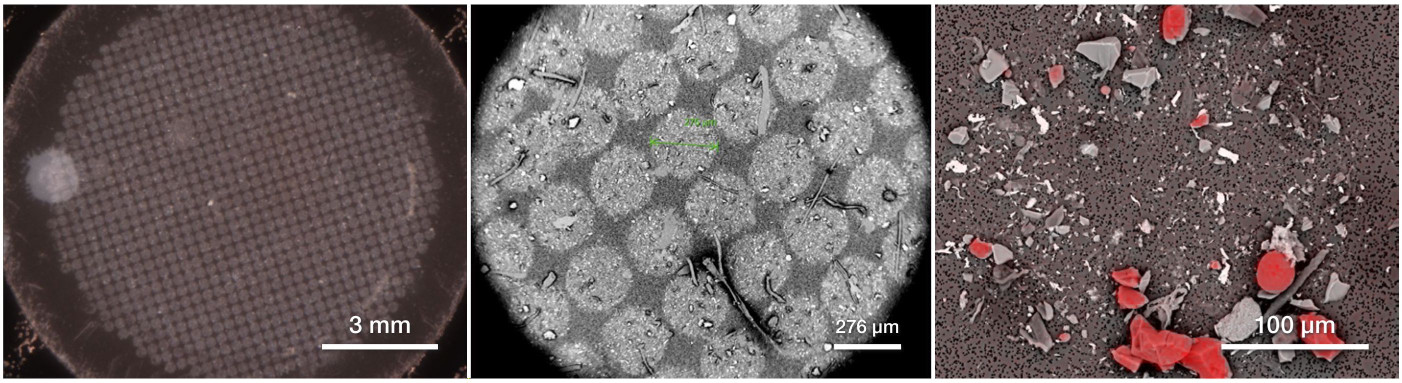
Microplastic identification with EDS

Determining the composition of microplastic contaminants starts with accurate particle identification. Microplastics are notoriously difficult to visually differentiate from other ocean sediment, necessitating chemical classification. Energy-dispersive X-ray spectroscopy (EDS) is a surface analysis technique found in many scanning electron microscopes (SEMs) that can clearly map the chemical composition of an imaged area. When searching for microplastics, researchers need to look for a hallmark element, such as chlorine in PVC (polyvinyl chloride) particles.

The challenge is that EDS mapping can be quite slow across an entire sample area—each pixel in the image consists of an EDS spectrum that might take only a few seconds to collect, but when added together, this results in hours of data collection. Frustratingly, much of this time is spent collecting data on empty areas of the sample. This is why researchers at the Bavarian State Office for Environmental Science (German: Bayerisches Landsamt für Umwelt, LfU Bayern) approached Thermo Fisher Scientific to collaborate on a way to expedite this process.

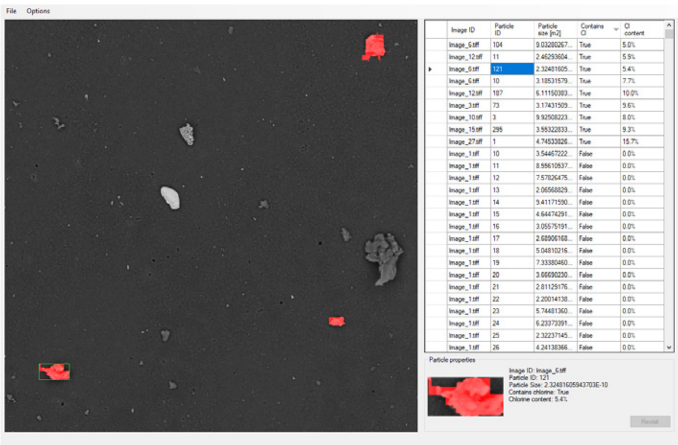
Distinguishing PVC microplastics in mollusks

As part of their research, scientists at LfU Bayern sought to quantify the PVC microplastic content in mollusks. By determining how many particles mollusks take in, they could begin to estimate how environmental microplastics might work their way into our food supply. Mollusk samples were first exposed to a microplastic-rich environment, then homogenized and filtered. This filter was then imaged with SEM-EDS, and chlorine-rich areas were manually isolated and quantified.



Multiscale imaging of the filtrate from a mollusk sample. Left) Overview of filter. Middle) SEM image showing particles of various types and dimensions. Manual identification of PVC microplastics is nearly impossible without additional chemical information. Right) EDS data overlaid onto SEM image, indicating the presence of chlorine (red).

Thermo Fisher Scientific sought to not only automate but also greatly expedite the multi-hour data collection. To that end, we developed Chloroscan Software for the Thermo Scientific™ Phenom™ ProX Desktop SEM. This unique software begins by automatically identifying potential micro-scale particles using image analysis. EDS analyses are subsequently performed solely at the center of each particle. This drastically reduces the overall data collection time while still providing the necessary quantification results.



Once the analysis is complete, the software indicates which particles contain chlorine above the user-defined threshold.

Conclusions

To increase our understanding of microplastic contamination, we will need more robust and reliable tools for particle identification. SEM-EDS is a valuable technique for the visualization and chemical identification of microplastics—with the addition of custom automation software, such classification can become an integrated, easy component of microplastic analysis. We hope that the possibilities introduced by Chloroscan Software inspire further application of SEM-EDS for both routine and advanced microplastics research.

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